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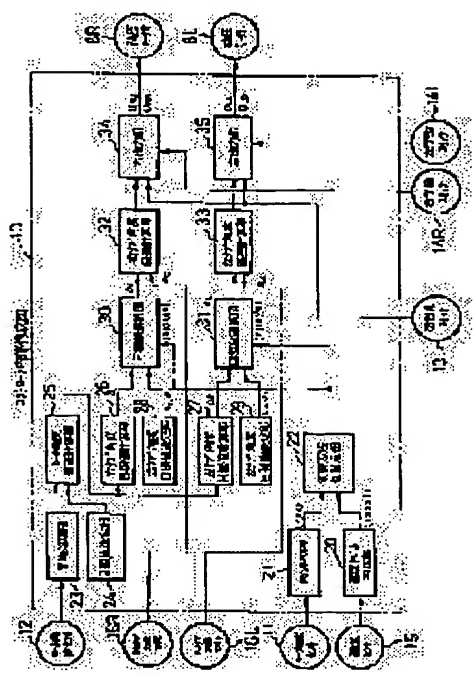
(54) AUTOMATIC ATTITUDE CONTROL DEVICE FOR SHIP

(57)Abstract:

PURPOSE: To automatically control the attitude efficiently and with high accuracy according to the navigating condition of a ship.

CONSTITUTION: An automatic attitude control device comprises a trim tab, a controller 10, driving means 8R, 8L for changing the angle of the trim tab, a roll angle sensor 12, a yaw angle signal sensor 11, a speed sensor 15 and trim tab angle sensors 16R, 16L, wherein the controller 10 determines the navigating condition of a ship from a yaw angle signal and a speed signal, and controls the angle of the trim tab in response to a roll angle signal and a trim tab angle signal according to the navigating condition.



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CLAIMS

[Claim(s)]
[Claim 1] Automatic attitude control equipment of a marine vessel characterized by providing the following A roll angle sensor which outputs a roll angle signal according to a roll angle of a hull A driving means which changes an angle of a trim tab according to an output signal which connects with a sensor, a speed sensor which outputs a speed signal according to vessel speed, a trim tab which controls a position of a hull, a controller which outputs a signal according to NAV conditions from said sensor, and this controller whenever [yaw angle / which outputs a signal whenever / yaw angle / according to whenever / yaw angle / of a hull], and is sent from a controller
[Claim 2] Automatic attitude control equipment of a marine vessel characterized by providing the following A roll angle sensor which outputs a roll angle signal according to a roll angle of a hull The driving means which changes the angle of a trim tab according to the output signal which connects with a sensor, a speed sensor which outputs a speed signal according to vessel speed, a trim-tab angle sensor which outputs an angle signal according to an actuation angle of a trim tab, the trim tab which controls a position of a hull, the controller which outputs a signal according to NAV conditions from said sensor, and this controller whenever [yaw angle / which outputs a signal whenever / yaw angle / according to whenever / yaw angle / of a hull], and is sent from a controller
[Claim 3] It is automatic attitude control equipment of a marine vessel which is equipped with the following and characterized by said controller controlling an angle of said trim tab by said roll angle signal and said trim-tab angle signal according to a NAV condition while judging a NAV condition of a ship from a signal and said speed signal whenever [said yaw angle]. A trim tab which controls a position of a hull A controller which outputs a signal according to NAV conditions A driving means which changes an angle of a trim tab according to an output signal which connects with this controller and is sent from a controller A roll angle sensor which outputs a roll angle signal according to a roll angle of a hull, a speed sensor which outputs a speed signal, corresponding to a signal sensor and vessel speed whenever [yaw angle / which outputs a signal whenever / yaw angle / according to whenever / yaw angle / of a hull], and a trim-tab angle sensor which outputs an angle signal according to an actuation angle of a trim tab

[Claim 4] Automatic attitude control equipment of a marine vessel characterized by providing the following. A trim tab which controls a position of a hull A controller which outputs a signal according to NAV conditions A driving means which changes an angle of a trim tab according to an output signal which connects with this controller and is sent from a controller A roll angle sensor which outputs a roll angle signal according to a roll angle of a hull, Whenever [yaw angle / which outputs a signal whenever / yaw angle / according to whenever / yaw angle / of a hull] A sensor, It consists of a speed sensor which outputs a speed signal according to vessel speed, and a trim-tab angle sensor which outputs an angle signal according to an actuation angle of a trim tab. The rate-of-change count section which said controller considers a signal as an input whenever [said yaw angle], and outputs a rate-of-change signal whenever [yaw angle], The velocity level judging section which considers a speed signal as an input and outputs a

speed level signal, The average processing.section which has the control method change section which considers a rate-of-change signal and said speed level signal as an input whenever [said yaw angle], judges a NAV condition, and outputs a control change signal, and equalizes said roll angle signal, and outputs a signal whenever [heel-angle], Whenever [heel-angle / which considers / whenever / heel-angle / a desired value signal as an input whenever / signal and heel-angle / and outputs a deflection signal whenever / heel-angle] The deflection count section, The tab angle desired value count section which considers a deflection signal as an input whenever [heel-angle], and calculates desired value of a trim-tab angle, The desired value selection section which has the tab angle desired value setting-out section which has set up a target trim-tab angle beforehand, chooses tab angle desired value with said control method change signal further, and outputs tab angle desired value, The output section which considers as an input a tab angle deflection signal and a tab angle deflection signal which consider tab angle desired value and a trim-tab angle signal as an input, and calculate tab angle deflection, and outputs a driving signal

[Claim 5] claim 1, claim 2, claim 3, or automatic attitude control equipment of a marine vessel according to claim 4 -- it is -- said controller -- each of said sensor signal -- an input -- carry out -- NAV conditions -- respond -- whenever [heel angle] -- control and turning tense -- a bow -- the automatic attitude control equipment of the marine vessel characterize by to output desired value which chose control whenever [in a relief condition / angle of trim], and was determined in each control method.

[Claim 6] It is automatic attitude control equipment of a marine vessel characterized by being automatic attitude control equipment of a marine vessel according to claim 5, and for control judging [whenever / said heel-angle] a NAV condition with a signal and said speed signal whenever [said yaw angle], and controlling an angle of said trim tab by signal and said trim-tab angle signal whenever [heel-angle].

[Claim 7] Automatic attitude control equipment of a marine vessel characterized by controlling a trim tab to desired value set up beforehand when it is automatic attitude control equipment of a marine vessel according to claim 5, a NAV condition is judged from a signal and said speed signal whenever [said yaw angle] and it is judged as the time of turning.

[Claim 8] automatic attitude control equipment of a marine vessel according to claim 5 -- it is -- said bow -- automatic attitude control equipment of a marine vessel characterized by for control judging a NAV condition from said speed signal, and controlling a trim tab to desired value set up beforehand whenever [in a relief condition / angle-of-trim].

[Claim 9] It is automatic attitude control equipment of a marine vessel characterized by being claim 1, claim 2, claim 3, claim 4, claim 5, claim 6, claim 7, and automatic attitude control equipment of a marine vessel according to claim 8, and for said roll angle detecting angular velocity of the roll direction of a hull with an oscillating gyroscope, and integrating with and computing said angular velocity.

[Claim 10] It is automatic attitude control equipment of a marine vessel characterized by being claim 1, claim 2, claim 3, claim 4, claim 5, claim 6, claim 7, and automatic attitude control equipment of a marine vessel according to claim 8, and for said roll angle detecting acceleration of the roll direction of a hull with an accelerometer, and computing a tilt angle of said hull based on said acceleration.

[Claim 11] It is automatic attitude control equipment of a marine vessel characterized by being claim 1, claim 2, claim 3, claim 4, claim 5, claim 6, claim 7, and automatic attitude control equipment of a marine vessel according to claim 8, and said roll angle detecting a tilt angle of the roll direction of a hull with an inclinometer.

[Claim 12] It is claim 1, claim 2, claim 3, claim 4, claim 5, claim 6, claim 7, and automatic attitude control equipment of a marine vessel according to claim 8, and whenever [said yaw angle] detects relative bearing of a hull with a magnetometric sensor, and is characterized by outputting this as whenever [yaw angle]. Automatic attitude control equipment of a marine vessel [Claim 13] Automatic attitude control equipment of a marine vessel which is automatic attitude control equipment of a marine vessel according to claim 5, has a device which controls said trim tab automatically, and a device driven with hand control, and is characterized by being switchable to

arbitration in this automatic and hand control.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the automatic attitude control equipment of the marine vessel which controls the angle of a trim tab automatically in order to stabilize the position of marine vessels, such as a motorboat.
[0002]
[Description of the Prior Art] As automatic attitude control equipment of the conventional marine vessel, there are some which were shown, for example in JP,3-82697,A and JP,3-114996,A.
[0003] The thing of JP,3-82697,A is a configuration which similarly controls a trim-tab angle according to the output of a sensor and a roll angle sensor whenever [torque-sensor / which detects the amount of control /, and helix-angle / which detects the position of a hull according to the output of the speed sensor which detects vessel speed].
[0004] In JP,3-114996,A, it has composition which similarly controls a trim-tab angle according to the output of a sensor and a roll angle sensor whenever [helix-angle / which detects the position of a hull].
[0005]
[Problem(s) to be Solved by the Invention] However, the thing given in JP,3-82697,A did not detect the position of a hull itself, but determined the angle of a trim tab uniquely that a bow will not come floating according to vessel speed at the time of abbreviation rectilinear propagation, and since it had become the configuration which controls the angle of a trim tab so that the heel (heel angle) of a hull might be made to ease according to amounts of control at the time of the reliance rudder operation by the time of turning, a cross wind, etc., it had caused the following problems.
[0006] ** A heel and rolling cannot be thoroughly prevented at the time of abbreviation rectilinear propagation.
[0007] ** Since it becomes the factor which loses the travelling-figure balance of a ship, it is not effective to control a trim-tab angle regardless of the position of the hull before turning steering and under turning steering at the time of turning.
[0008] Moreover, controlling a trim tab in the direction which reduces the inner dip which is an effective position for originally resisting a centrifugal force (lateral acceleration) at the time of turning increases the lateral acceleration which crew feels, and it may give crew sense of incongruity.
[0009] Although a thing given in JP,3-114996,A, on the other hand, also has the composition which detects whenever [helix-angle], and the roll angle showing the position of a ship itself, is the configuration which controls a trim-tab angle, gives and carries out the comparison operation of whenever [aim helix-angle], and the aim roll angle further, and controls a trim-tab angle and control of a roll angle and whenever [helix-angle] was always performing regardless of the NAV condition of a ship, there were the following problems.
[0010] ** Since change or rudder angle change is not detected whenever [yaw angle / of a ship], turning steering for course modification will not be able to be detected and it will be

controlled in the direction which reduces inner dip too at the time of turning.
[0011] ** Since the oscillation angle is always controlled, the load of the actuators (a motor, oil hydraulic cylinder, etc.) which drive a trim tab becomes high.
[0012] Then, this invention is doubled with the NAV condition of a ship, and aims at efficient and offer of the automatic attitude control equipment of a marine vessel which can perform attitude control of high degree of accuracy.
[0013]
[Means for Solving the Problem] In order to solve the above-mentioned technical problem invention of claim 1 A roll angle sensor which outputs a roll angle signal according to a roll angle of a hull, Whenever [yaw angle / which outputs a signal whenever / yaw angle / according to whenever / yaw angle / of a hull] A sensor, A speed sensor which outputs a speed signal according to vessel speed, and a trim tab which controls a position of a hull, a controller which outputs a signal according to NAV conditions from said sensor, and a driving means which changes an angle of a trim tab according to an output signal which connects with this controller and is sent from a controller — since — it is characterized by becoming.
[0014] A roll angle sensor to which invention of claim 2 outputs a roll angle signal according to a roll angle of a hull, Whenever [yaw angle / which outputs a signal whenever / yaw angle / according to whenever / yaw angle / of a hull] A sensor, A speed sensor which outputs a speed signal according to vessel speed, and a trim-tab angle sensor which outputs an angle signal according to an actuation angle of a trim tab, It connects with a trim tab which controls a position of a hull, a controller which outputs a signal according to NAV conditions from said sensor, and this controller, and is characterized by consisting of a driving means which changes an angle of a trim tab according to an output signal sent from a controller.
[0015] A trim tab by which invention of claim 3 controls a position of a hull, and a controller which outputs a signal according to NAV conditions, A driving means which changes an angle of a trim tab according to an output signal which connects with this controller and is sent from a controller, A roll angle sensor which outputs a roll angle signal according to a roll angle of a hull, Whenever [yaw angle / which outputs a signal whenever / yaw angle / according to whenever / yaw angle / of a hull] A signal sensor, It consists of a speed sensor which outputs a speed signal according to vessel speed, and a trim-tab angle sensor which outputs an angle signal according to an actuation angle of a trim tab. Said controller is characterized by controlling an angle of said trim tab by said roll angle signal and said trim-tab angle signal according to a NAV condition while it judges a NAV condition of a ship from a signal and said speed signal whenever [said yaw angle].
[0016] A trim tab by which invention of claim 4 controls a position of a hull, and a controller which outputs a signal according to NAV conditions, A driving means which changes an angle of a trim tab according to an output signal which connects with this controller and is sent from a controller, A roll angle sensor which outputs a roll angle signal according to a roll angle of a hull, Whenever [yaw angle / which outputs a signal whenever / yaw angle / according to whenever / yaw angle / of a hull] A sensor, It consists of a speed sensor which outputs a speed signal according to vessel speed, and a trim-tab angle sensor which outputs an angle signal according to an actuation angle of a trim tab. The rate-of-change count section which said controller considers a signal as an input whenever [said yaw angle], and outputs a rate-of-change signal whenever [yaw angle], The velocity level judging section which considers a speed signal as an input and outputs a speed level signal, The average processing section which has the control method change section which considers a rate-of-change signal and said speed level signal as an input whenever [said yaw angle], judges a NAV condition, and outputs a control change signal, and equalizes said roll angle signal, and outputs a signal whenever [heel-angle], Whenever [heel-angle / which considers / whenever / heel-angle / a desired value signal as an input whenever / signal and heel-angle / and outputs a deflection signal whenever / heel-angle] The deflection count section, The tab angle desired value count section which considers a deflection signal as an input whenever [heel-angle], and calculates desired value of a trim-tab angle, The desired value selection section which has the tab angle desired value setting-out section which has set up a target trim-tab angle beforehand, chooses tab angle desired value

with said control method change signal further, and outputs tab angle desired value, It is characterized by having the output section which considers as an input a tab angle deflection signal and a tab angle deflection signal which consider tab angle desired value and a trim-tab angle signal as an input, and calculate tab angle deflection, and outputs a driving signal.
[0017] invention of claim 5 — claim 1, claim 2, claim 3, or automatic attitude control equipment of a marine vessel according to claim 4 — it is — said controller — said each sensor signal — an input — carry out — NAV conditions — respond — whenever [heel angle] — control and turning tense — a bow — control is choose whenever [in a relief condition / angle of trim], and it is characterize by output desired value determined in each control method.
[0018] Invention of claim 6 is automatic attitude control equipment of a marine vessel according to claim 5, and whenever [said heel-angle], control judges a NAV condition with a signal and said speed signal whenever [said yaw angle], and is characterized by controlling an angle of said trim tab by signal and said trim-tab angle signal whenever [heel-angle].
[0019] Invention of claim 7 is automatic attitude control equipment of a marine vessel according to claim 5, and it is characterized by controlling a trim tab to desired value set up beforehand, when a NAV condition is judged from a signal and said speed signal and it is judged as the time of turning whenever [said yaw angle].
[0020] invention of claim 8 — automatic attitude control equipment of a marine vessel according to claim 5 — it is — said bow — it is characterized by for control judging a NAV condition from said speed signal, and controlling a trim tab to desired value set up beforehand whenever [in a relief condition / angle-of-trim].
[0021] Invention of claim 9 is claim 1, claim 2, claim 3, claim 4, claim 5, claim 6, claim 7, and automatic attitude control equipment of a marine vessel according to claim 8, and said roll angle detects angular velocity of the roll direction of a hull with an oscillating gyroscope, and is characterized by integrating with and computing said angular velocity.
[0022] Invention of claim 10 is claim 1, claim 2, claim 3, claim 4, claim 5, claim 6, claim 7, and automatic attitude control equipment of a marine vessel according to claim 8, and said roll angle detects acceleration of the roll direction of a hull with an accelerometer, and is characterized by computing a tilt angle of said hull based on said acceleration.
[0023] Invention of claim 11 is claim 1, claim 2, claim 3, claim 4, claim 5, claim 6, claim 7, and automatic attitude control equipment of a marine vessel according to claim 8, and said roll angle is characterized by detecting a tilt angle of the roll direction of a hull with an inclinometer.
[0024] Invention of claim 12 is claim 1, claim 2, claim 3, claim 4, claim 5, claim 6, claim 7, and automatic attitude control equipment of a marine vessel according to claim 8, and whenever [said yaw angle] detects relative bearing of a hull with a magnetometric sensor, and is characterized by outputting this as whenever [yaw angle].
[0025] Invention of claim 13 is automatic attitude control equipment of a marine vessel according to claim 5, has a device which controls said trim tab automatically, and a device driven with hand control, and is characterized by being switchable to arbitration in this automatic and hand control.
[0026]
[Function] According to invention of claim 1 of the above-mentioned means, the roll angle of a hull, and whenever [yaw angle], based on vessel speed, a driving means can be controlled by the controller and the angle of a trim tab can be changed.
[0027] According to invention of claim 2, the roll angle of a hull, and whenever [yaw angle], based on the angle of vessel speed and a trim tab, a controller can control a driving means, and the angle of a trim tab can be changed.
[0028] According to invention of claim 3, whenever [yaw angle], from a signal and a speed signal, the NAV condition of a ship can be judged and the angle of a trim tab can be controlled by the roll angle signal and the trim-tab angle signal according to a NAV condition.
[0029] According to invention of claim 4, input rate of change and a velocity level whenever [yaw angle], and a NAV condition is judged. Deflection is calculated [whenever / heel-angle / which enabled the change of the control method based on the judgment of this NAV condition, and equalized the roll angle signal / whenever / signal and heel-angle] whenever [heel-angle]

with a desired value signal. The desired value of a trim-tab angle is calculated by considering a deflection signal as an input whenever [this heel-angle]. Moreover, a target trim-tab angle is set up beforehand, tab angle desired value is further chosen with the control method change signal, tab angle desired value is outputted, tab angle deflection can be calculated by the ability to input tab angle desired value and a trim-tab angle signal, and a driving signal can be outputted.

[0030] according to invention of claim 5 — a NAV condition — responding — whenever [heel-angle] — control and turning tense — a bow — the trim-tab angle control in a relief condition can be chosen, and the desired value determined in each control method can be outputted.
[0031] According to invention of claim 6, from a signal and a speed signal, a NAV condition can be judged, the angle of a trim tab can be controlled by the signal and the trim-tab angle signal whenever [heel-angle], and it can control [whenever / yaw angle] whenever [heel-angle].
[0032] According to invention of claim 7, when a NAV condition is judged and it is judged as the time of turning from a signal and a speed signal whenever [yaw angle], a trim tab can be set as the desired value set up beforehand.
[0033] According to invention of claim 8, a NAV condition can be judged with a speed signal and a trim tab can be controlled to the desired value set up beforehand.
[0034] According to invention of claim 9, a roll angle can be computed by the ability for an oscillating gyroscope to detect the angular velocity of the roll direction of a hull, and integrate with angular velocity.
[0035] According to invention of claim 10, an accelerometer can detect the acceleration of the roll direction of a hull, the tilt angle of a hull can be computed based on this acceleration, and it can ask for a roll angle.
[0036] According to invention of claim 11, an inclinometer can detect the tilt angle of the roll direction of a hull, and it can ask for a roll angle.
[0037] According to invention of claim 12, a magnetometric sensor can detect the relative bearing of a hull and this can be outputted as whenever [yaw angle].
[0038] According to invention of claim 13, an automatic and hand control can be changed to arbitration and a trim tab can be controlled.
[0039]
[Example] Hereafter, the example of this invention is explained.
[0040] Drawing 1 is the general drawing of a system configuration seen from the hull upper part.
[0041] 1 is a hull, 2 is a handle and he is trying for the turning effort of a handle 2 to rock a screw 5 right and left through a wire 3. Said screw 5 which can give turning effort with an engine 4 is connected to an engine 4. He changes the direction of a thrust and is trying to make it circle in a hull by rocking a screw 5 right and left by the revolution of a handle 2.
[0042] The sensor 11, the roll angle sensor 12 which detects the oscillation angle of the longitudinal direction of a hull, and the speed sensor 15 which detects the speed of a hull are connected to a controller 10 whenever [yaw angle / which detects the deflection angle to the longitudinal direction of a bow]. In addition, a roll angle can detect the angular velocity of the roll direction to a hull with an oscillating gyroscope, and can integrate with and compute said angular velocity. Moreover, it can ask by an accelerometer's detecting the acceleration of the roll direction of a hull and computing the tilt angle of a hull based on this acceleration. Furthermore, it can ask for a roll angle by detecting the tilt angle of the roll direction of a hull with an inclinometer. Whenever [yaw angle] can detect the relative bearing of a hull with a magnetometric sensor, and can output this as whenever [yaw angle].
[0043] He is trying to input into a controller 10 Signal omega, and the roll angle signal phi detected by the roll angle sensor 12 and the speed signal upsilon detected by the speed sensor 15, respectively whenever [yaw angle / which was detected by the sensor 11 whenever / said yaw angle].
[0044] Moreover, the manually-operated switch (14R for right trim tabs, 14L for left trim tabs) for operating manually the transfer switch 13 and trim tabs 6R and 6L which switch whether the angle sensor (16R for right trim tabs, 16L for left trim tabs) which detects the angle of trim tabs 6R and 6L, and trim tabs 6R and 6L are controlled automatically, or it operates manually is

connected to a controller 10.
[0045] Furthermore, the controller 10 is connected with the battery 9 through an electric power switch 17. When an electric power switch 17 is OFF, it has composition which actuation of a controller 10 suspends.
[0046] The controller 10 has connected the output to the driving means which changes the angle of trim tabs 6R and 6L according to the signal outputted from a controller 10.
[0047] The driving means of the trim tabs 6R and 6L of this example is constituted as follows. An output signal is embraced from a controller 10, and hydraulic motors 8R and 8L are rotated normally and reversed. According to normal rotation of hydraulic motors 8R and 8L and reversal, Cylinders 7R and 7L perform flexible motion. Trim tabs 6R and 6L are made to move up and down by flexible motion of these cylinders 7R and 7L.
[0048] Next, drawing 2 explains the internal configuration of a controller 10.
[0049] A speed signal upsilon is first inputted into a controller 10 from said speed sensor 15, and this speed signal v is sent to the velocity level judging section 20.
[0050] The constant value v1 for judging a NAV condition and v2 (v1 and <v2) are beforehand set as the interior by this velocity level judging section 20. v1 the bow of a ** idling condition and a ship — it is a boundary value with a relief condition. v2 It is the boundary value of a ****** relief condition and a plane condition. This v1 and v2 A value can be set as any value according to the NAV conditions of a ship, or the property of a hull.
[0051] In addition, a property as generally shown in drawing 3 has the relation between vessel speed and an angle of trim.
[0052] In said velocity level judging section 20, the velocity level of a ship is classified into the following three kinds by the following judgment type.
[0053]
(1) v<v1 (idling condition)
(2) v1 <=v<=v2 (bow relief condition)
(3) v2 <v1 (plane condition) — At the time of the conditions of the 1st formula (1) (1) signal is outputted to the control method change section 22.
[0054] At the time of the conditions of (2) (2) signals are outputted to the control method change section 22.
[0055] At the time of the conditions of (3) (3) signals are outputted to the control method change section 22.
[0056] Moreover, if Signal upsilon is inputted [whenever / said yaw angle] into a controller 10 whenever [yaw angle] from a sensor 11, Signal omega will be sent to the rate-of-change count section 21 whenever [this yaw angle].
[0057] According to Signal omega, it is [whenever / yaw angle / which was inputted in this rate-of-change count section 21] rate of change whenever [yaw angle / which is change whenever / yaw angle / for every unit time amount]. domega/dt It calculates. And it is rate of change whenever [yaw angle / which was calculated]. d omega/dt The rate-of-change count section 21 carries out a comparison operation to constant value domegao/dt set up beforehand, and chooses an output signal. Domegao/dt is a boundary value the NAV condition of a ship judges the time of current, rectilinear propagation, and turning to be. this — The value of domegao/dt can be set as any value according to the NAV conditions of a ship, or the property of a hull. (**) d omega/dt < Domegao/dt (at the time of rectilinear propagation)
(**) d omega/dt >= Domegao/dt (at the time of turning) — 2nd formula (b) At the time of conditions (b) A signal is outputted to the control method change section 22.
[0058] (b) At the time of ****** (b) A signal is outputted to the control method change section 22.
[0059] Instruction signal when the speed level signal from the aforementioned velocity level judging section 20 and the rate-of-change signal from the aforementioned rate-of-change count section 21 are inputted into the control method change section 22, as shown in drawing 4 in the control method change section 22 with the combination of the speed level signal and rate-of-change signal which were inputted (i) - (iii) It determines and outputs to the desired value selection sections 30 and 31.

[0060] Change instruction signal (i) – (iii) (i) Instruction signal changed into the condition of having raised the trim tab to the top
(ii) Instruction signal which changes a trim tab into the condition of having lowered to the bottom

(iii) Instruction signal which controls whenever [heel-angle]
It means.
[0061] Namely, it is a change instruction signal (i) regardless of a judgment at the time of rectilinear propagation [in / when the velocity level of the ship in the 1st formula is judged to be an idling condition / the 2nd formula], and turning. That is, a trim tab is controlled in the condition of having raised to the top.
[0062] moreover, the velocity level in the 1st formula — a bow — when it judges with a relief condition (run state before plane shift), the change instruction signal (ii) 6R and 6L, i.e., trim tabs, is controlled in the condition of having lowered most, regardless of a judgment at the time of the rectilinear propagation in the 2nd formula, and turning.
[0063] This has the effective control which was mentioned above and which lowers a bow until it shifts to a plane condition like, and control is because there is little effectiveness whenever [rolling control-in this condition, and heel-angle].
[0064] furthermore, the case where it is judged with the time of rectilinear propagation by the 2nd formula when the velocity level in the 1st formula is judged to be a plane condition — change instruction signal (iii) namely, the case where control is judged whenever [heel-angle] to be the time of operation and turning — change instruction signal (i) That is, it controls in the condition of having raised trim tabs 6R and 6L most.
[0065] Thereby, at the time of rectilinear propagation, only a plane condition controls whenever [heel-angle] and it controls not to check the heel which is the property which a ship originally has at the time of turning.
[0066] On the other hand, the roll angle signal phi is inputted into a controller 10 from the roll angle sensor 12, and this roll angle signal phi is sent to the average processing section 23.
[0067] In this average processing section 23, from the inputted roll angle signal phi, the 3rd following formula is calculated and a moving average deviation is calculated. This moving average deviation is set to heel-angle whenever phia.
[0068]
[Equation 1]

$$\phi a k = \frac{1}{n'} \sum_{i=k-n'}^{k} \phi i \qquad \cdots第3式$$

ここでiは (k−n'), (k−n'+1), (k−n'+2), ……, k

{K− (k−n'+n')}

As for roll angle phiak in i event, phii shows whenever [in k event / heel-angle].
[0069] phiak, i.e., phii, is n'. It is the average of the value which ****(ed).
[0070] phi makes the right dip direction positive to a travelling direction.
[0071] phia is made into an output signal whenever [heel-angle / which was calculated by the 3rd formula], and it outputs to the heel-angle deflection count section 25.
[0072] It is signal phio whenever [aim heel-angle / which shows whenever / aim heel-angle / which is beforehand set to this heel-angle deflection count section 25 in the desired value decision section 24 in addition to this]. It has inputted.
[0073] In this heel-angle deflection count section 25, the 4th following formula is calculated and it asks for deflection signal phie whenever [heel-angle].
[0074]
phie=phia-phio — A hull makes the clockwise direction positive to a travelling direction here the

4th formula.
[0075] Deflection signal phie is outputted to the tab angle desired value count sections 26 and 27 whenever [this heel-angle].
[0076] In the tab angle desired value count section 26, whenever [heel-angle / which was inputted], after judging the positive/negative of phie based on deflection signal phie, the PID operation of the 5th formula is performed and it asks for tab angle desired value thetar of a right trim tab.
[0077]
[Equation 2]
$\phi e \geqq 0$なら

$$\theta r - K_p \phi_e + T_D \frac{d}{dt} \phi_e + \frac{1}{T_I} \int \phi_e \, dt \quad \cdots 第5式$$

$\phi e < 0$なら

$$\theta r = 0$$

ここで、K_p，T_D，T_I は定数である。

Whenever [heel-angle / which was inputted in the tab angle desired value count section 27], after judging the positive/negative of phie based on deflection signal phie, the following PID operation of the 6th formula is performed and it is tab angle desired value thetal of left trim-tab 6L. It asks.
[0078]
[Equation 3]
$\phi e \geqq 0$なら

$$\theta \ell - 0$$

$\phi e < 0$なら

$$\theta \ell = -\left(K_p \phi_e + T_D \frac{d}{dt} \phi_e + \frac{1}{T_I} \int \phi_e \, dt\right) \quad \cdots 第6式$$

ここで、K_p，T_D，T_I は定数である。

In addition, the 1st term Kpphie of the 6th formula gives the tab angle proportional to deflection signal phie whenever [heel-angle] to the 5th formula list. That is, the tab angle of the right or the left is enlarged, so that the absolute value of deflection signal phie is [whenever / heel-angle] large.
[0079] This 2nd term does not give the tab angle proportional to the differential value of deflection signal phie whenever [heel-angle], if this differential value is not large, it gives that much big tab angle, and it is raising the responsibility which decreases whenever [heel-angle /

of a hull].
[0080] This 3rd term gives the tab angle proportional to the integral value of deflection signal phie whenever [heel-angle], and this has given the tab angle which negates the heel (whenever [heel-angle]) of the steady hull produced according to the property and external force of a hull.

[0081] Right tab angle desired value thetar called for here is outputted to the desired value selection section 30. Moreover, left tab desired value thetal It is outputted to the desired value selection section 31.
[0082] Explanation to the output signal decision of a right trim tab is given to below. The flow to the output signal decision of a left trim tab is completely the same as a right trim tab, and explanation is omitted.
[0083] Change instruction signal outputted to the aim selection section 30 from the above mentioned control method change section 22 (i) - (iii) The right tab angle desired value setting-out section 28 which set up the aim tab angle beforehand although tab angle desired value thetar outputted from the right tab angle desired value count section 26 was inputted to the aim set point theta 1, and theta 2 It has inputted. Aim set point theta 1 It is the set point in the condition of having raised trim-tab 6R most. Aim set point theta 2 It is the set point in the condition of having lowered trim-tab 6R most.
[0084] At the desired value selection section 30, it is a change instruction signal (i). - (iii) It corresponds and is desired value thetar of a right tab angle, theta 1, and theta 2. It chooses. The selection response is as follows.
[0085]
change instruction signal Tab angle desired value (i) The time theta 1 Selection (ii) The time theta 2 Selection (iii) The time thetar selection -- the right tab angle desired value chosen by this -- thetaR =theta1 -, theta 2, or thetar ** -- it carries out.
[0086] Right tab angle desired value thetaR chosen in the desired value selection section 30 It is outputted to the right tab angle deflection count section 32.
[0087] Tab angle desired value thetaR inputted into the right tab angle deflection count section 32 Angle signal thetaRo detected by trim-tab angle sensor 16R is also inputted into others.
[0088] The 7th following formula is calculated in the right tab angle deflection count section 32, and it is deviation angle whenever thetae. It asks. thetae =thetaR-thetaRo -- It is thetae to the 7th formula pan. Positive/negative distinction is performed and it is deviation angle thetae. The signal which rises and brings down trim-tab 6R so that it may become zero is determined as follows.
[0089]
thetae When it is positive Down signal (ORD)
thetae When it is negative Rise signal (ORU)
This rise down signal is outputted to the right output section 34.
[0090] In the right output section 34, the change signal and the manual ringing from right manual switch 14R which rise down signal ORU or ORD determined in the right tab angle deflection count section 32 is considered as an input, and also consider an on-off signal as an output from a changeover switch 13 are inputted.
[0091] That is, he is trying to change an automatic and manual trim-tab control in the right output section 34 with the change signal inputted from a changeover switch 13.
[0092] When a changeover switch 13 is ON, it considers as an automatic, and it outputs to hydraulic-motor 8R by making into an output signal rise down signal ORD or ORU determined above.
[0093] When a changeover switch 13 is OFF, it considers as hand control, and the rise down signal determined by actuation of right manual switch 14R is outputted to hydraulic-motor 8R as an output of the right output section 34.
[0094] Although control of right trim-tab 6R was explained above, the same is said of the left trim-tab 6L.
[0095] Here, there are little increase of water pressure which starts a ship's bottom since the draft of the stern is deep until it goes into a plane condition in a planing boat, and rolling. On the

other hand, since the shift to a plane becomes slow while a riser front field of view gets worse [a bow] by subduction of the stern, when right and left take down a trim tab conventionally, actuation which lowers a bow is performed and control of the example of this invention also applies to this in the meantime.
[0096] On the other hand, in a plane condition, a draft becomes shallow and the oscillation of a ship becomes active. When rolling is compared with pitching in this condition, the pitching period is usually longer and the direction of rolling is felt sensitively. Moreover, although the effect of lowering the bow which went up too much on the structure, as for the attitude control using a trim tab is expectable, there is no effect of raising the bow which fell too much. Therefore, the attitude control in a plane condition has more effective control of rolling.
[0097] However, since a great quantity of loads will be given to a control actuator, always controlling all rolling does not tend to press down the oscillation angle (rolling) of a hull itself, and it controls the average attitude angle (this is called heel angle) by the example of this invention.
[0098] Moreover, about the invalid nature of the rolling control at the time of turning, although it is as above-mentioned, it uses that the level of rate of change differs whenever [in each / yaw angle] at the time of rectilinear propagation and turning for detection of a turning condition. That is, if the level which has rate of change whenever [yaw angle] is exceeded, it can be judged as turning.
[0099] Next, the control action of the above-mentioned controller 10 is explained based on the flow chart of drawing 9 from drawing 5 . In addition, also in this explanation, it carries out about control of right trim-tab 6R, and control of left trim-tab 6L is omitted.
[0100] First, overall control is performed like drawing 5 . That is, the change of the control method is performed in step S1. The change of this control method is said instruction signal (i). An instruction signal (ii) and instruction signal (iii) It is a change.
[0101] Tab angle count is performed at step S2. Tab angle count is performed based on detection of said roll angle sensor 12 (drawing 1).
[0102] Desired value selection is performed at step S3. Desired value selection embraces a NAV condition and is tab angle thetar, theta 1, and theta 2. It chooses.
[0103] In step S4, tab angle deflection count and an output are performed. Tab angle deflection count is selected desired value thetaR. It is calculated based on the trim-tab angle detected by trim-tab angle sensor 16R (drawing 1). An output outputs the signal of a rise or a down to hydraulic-motor 8R so that deflection may be set to 0.
[0104] Next, the details of step S1 - S4 are explained.
[0105] The change of the control method of said step S1 is performed by the routine of drawing 6 . At step S101, reading of the speed v detected by the speed sensor 15 (drawing 1) is performed first.
[0106] The judgment of a velocity level is performed at step S102. It is (1), as this judgment was performed in the velocity level judging section 20 (drawing 1) and being described above. v<v1 (2) v1 <=v<=v2 (3) It is carried out about v2 <v and is v<v1. A case is (1) at step S103. Selection of a signal is performed.
[0107] v1 <=v<=v2 A case is (2) at step S104. Selection of a signal is performed.
[0108] v2 In <v, set to step S105 and it is (3). Selection of a signal is performed.
[0109] Subsequently, reading of omega is performed whenever [yaw angle / which was detected by the sensor 11 (drawing 1) whenever / yaw angle / in step S106].
[0110] A judgment of a NAV condition is made at step S107. This decision is performed in the rate-of-change count section 21 (drawing 1), and as described above, it carries out about (b) d omega/dt<d omega0 / dt (b) d omega/dt>=d omega 0 / dt.
[0111] In d omega/dt<d omega 0 / dt, selection of a (b) signal is performed in step S108.
[0112] In d omega/dt>=d omega 0 / dt, selection of a (b) signal is performed at step S109. If these signal selections are performed, based on these signals, a judgment of speed and a NAV condition will be made in step S110. This judgment is made like said drawing 4 in the control method change section 22.
[0113] Namely, (1) And (**) and (1) And (**) and (3) It reaches, in (**), it sets to step S111, and is (i). Selection of a signal is performed.

[0114] (2) And (**) and (2) And in (**), selection of the (ii) signal is performed in step S112.
[0115] (3) And when it is (**), set to step S113 (iii). Selection of a signal is performed.
[0116] These (i) A signal and (ii) signal (iii), The change of the control method can be judged with a signal. therefore, the step S114 — setting — (i) or (ii) — or (iii) it was chosen — it changes and a signal is outputted.
[0117] Next, tab angle count of step S2 of said drawing 5 is performed by the routine of drawing 7 . In step S201, reading of detection roll angle phi is performed first. This reading is based on detection of said roll angle sensor 12 (drawing 1).
[0118] Subsequently, count of moving average deviation phia is performed in step S202. This average processing is performed in the average processing section 23 (drawing 1). Moving average deviation phia is outputted as whenever [heel-angle], as described above.
[0119] It sets to step S203 and is decision aim ground phio. Read in is performed. This decision aim ground phio It is based on the value beforehand determined in said desired value decision section 24 (drawing 1).
[0120] At step S204, deflection count is performed whenever [heel-angle]. Whenever [this heel-angle], deflection count is performed in the count section 25 (drawing 1) whenever [heel-angle], and phie =phia-phio is performed.
[0121] At step S205, it is tab angle desired value thetar. Count is performed. This count is performed in the right tab angle desired value count section 26 (drawing 1), as described above.

[0122] Next, it sets to step S206 and is tab angle thetar. An output is performed. This output is performed from the right tab angle desired value count section 26 to the desired value selection section 30.
[0123] Desired value selection of step S3 of said drawing 5 is performed based on the routine of drawing 8 . This routine is performed by the desired value selection section 30 (drawing 1).
[0124] It is tab angle count desired value thetar at step S301 first. Read in is performed. This desired value thetar It is based on the output from said desired value count section 26 (drawing 1).
[0125] At step S302, it is the tab angle setting-out desired value theta 1 and theta 2. Read in is performed. This desired value theta 1 and theta 2 It is based on the output from the right tab angle desired value setting-out section 28 (drawing 1).
[0126] It changes at step S303 and is a signal (i). (ii) (iii), Read in is performed. This read in is based on the output from said control method change section 22.
[0127] At step S304, it changes and decision of a signal is performed. (i) It sets to step S305 and a case is desired value theta 1. Selection is performed. In (ii), it sets to step S306 and is desired value theta 2. Selection is performed. (iii) It sets to step S307 and a case is desired value thetar. Selection is performed. The these-chosen desired value theta 1, theta 2, and thetar Either is desired value thetaR. It carries out and is outputted in step S308. This output is performed from said desired value selection section 30 to the right tab angle deflection count section 32.
[0128] The tab angle deflection count output of step S4 of said drawing 5 is performed by the routine of drawing 9 . This routine is performed by said right tab angle deflection count section 32 and the right output section 34.
[0129] The desired value theta 1 first chosen in step S401, theta 2, and thetar Read in is performed. This read in is based on the output from the desired value selection section 30 (drawing 1).
[0130] At step S402, read in of detected trim-tab angle thetaRO is performed. This read in is based on the output from said trim-tab angle sensor 16R (drawing 1).
[0131] Tab angle deflection count is performed at step S403. This count performs thetae =thetaR-thetaRO.
[0132] Subsequently, it sets to step 404 and is thetae. A positive/negative judging is performed. thetae When it is positive, the output of the down signal ORD is performed in step S405. thetae When it is negative, the rise signal ORU is outputted in step S406. Said hydraulic-motor 8R drives and a trim-tab angle is controlled by this output at a down or rise side.
[0133] And decision of being thetae =0 is performed in step S407, and control will be ended if

set to 0.
[0134] Thus, according to the NAV condition of a ship, trim tabs 6R and 6L can be controlled, and efficient and the position system of high degree of accuracy can be performed automatically. Moreover, the load of hydraulic motors 8L and 8R can be made into min, and endurance and reliability can be improved.
[0135] An example of the effect by the above-mentioned example of this invention is shown in drawing 10 .
[0136] Drawing 10 (a) Depressor effect is shown whenever [in every speed of a ship / heel-angle / in / for a cross wind / a carrier beam condition] at the time of rectilinear propagation.
[0137] As for a dashed line, in control by this invention example, in not controlling, the continuous line in drawing shows the case where a two-dot chain line performs rear-spring-supporter rolling control in the whole region, respectively.
[0138] It turns out to disturbance, such as a cross wind, that this invention example has depressor effect whenever [very effective heel-angle] so that clearly from these.
[0139] Moreover, since it is small, not in the degree as which human being senses displeasure but in this field, the control effect is known by that it is few, as the inclination in the field in front of non-controlled degree play NINGU of heel angle was described above.
[0140] Drawing 10 (b) The trim depressor effect by this invention is shown similarly. As for a dashed line, in control by this invention, in not controlling, the continuous line in drawing shows the case where a two-dot chain line performs rear-spring-supporter pitching control in the whole region, respectively.
[0141] the bow according to the trim inhibitory control before play NINGU by this invention example so that clearly from these — it turns out well the relief prevention effect is not only acquired, but that trim depressor effect continues after play NINGU which is trim control sheep regulatory region.
[0142] Moreover, even if it performs trim inhibitory control in a low-speed region and the maximum high-speed region, an effect is well known by that it is small.
[0143] As mentioned above, although the configuration of the above-mentioned example, control logic, the operation, and the effect were explained, this invention is not limited to the configuration and control logic of the above-mentioned example.
[0144] For example, it is a correction term for raising control precision about each 2nd term and each 3rd term in the 5th formula and the 6th formula, and it is also possible to omit one of these or both sides.
[0145] Moreover, it sets in the tab angle deflection count sections 32 and 33, and is deviation angle whenever thetae by the 7th formula. Although the rise down signal of a trim tab is outputted and driven in the output sections 34 and 35 after asking, it is also possible to drive a trim tab with the tab angle desired value itself chosen in the desired value selection sections 30 and 31.
[0146] In this case, the tab angle deflection count sections 32 and 33 and the trim-tab angle sensors 16R and 16L become omissible.
[0147] Moreover, in this configuration, a comparison operation with the roll angle after control is performed, and it cannot be overemphasized that feedback of the deflection by study etc. is possible.
[0148] It cannot be overemphasized that you may be the object which will not be limited to the object of a proper if said control is possible, and has two or more functions by one also about each sensor in an example.
[0149]
[Effect of the Invention] As mentioned above, according to invention of claim 1, control of a trim tab can be automatically controlled the roll angle of a hull, and whenever [yaw angle] according to vessel speed, and attitude control of high degree of accuracy can be automatically performed so that clearly.
[0150] According to invention of claim 2, control of a trim tab can be automatically controlled a roll angle and whenever [yaw angle] according to vessel speed and the detected trim-tab angle, and attitude control of high degree of accuracy can be performed more automatically.

[0151] According to invention of claim 3, whenever [yaw angle], from a signal and a speed signal, the NAV condition of a ship can be judged and the angle of a trim tab can be controlled by this. Therefore, it can double with the NAV condition of a ship and attitude control of efficient and high degree of accuracy can be performed automatically.
[0152] According to invention of claim 4, based on rate of change and a velocity level judging, a NAV condition can be judged whenever [yaw angle], and the control method can be changed. And tab angle desired value can be chosen with the change signal of the control method, and a driving signal can be outputted. Therefore, attitude control of high degree of accuracy can be performed more automatically.
[0153] whenever [heel-angle / which was chosen according to NAV conditions in invention of claim 5] — control and turning tense — a bow — the desired value determined in control whenever [in a relief condition / angle-of-trim] is outputted, and control according to NAV conditions can be performed accurately.
[0154] In invention of claim 6, whenever [yaw angle], from a signal and a speed signal, a NAV condition can be judged, the angle of a trim tab can be controlled with a signal and a trim-tab angle signal whenever [heel-angle], and more accurate control can be performed.
[0155] When it is judged as the time of turning according to invention of claim 7, a trim tab can be controlled to the desired value set up beforehand, and control at the time of turning can be performed more accurately.
[0156] according to invention of claim 8 — a bow — it is [whenever / angle-of-trim / in a relief condition] accurately controllable.
[0157] A roll angle can be computed by the ability for an oscillating gyroscope to detect the angular velocity of the roll direction of a hull according to invention of claim 9, and integrate with angular velocity, and exact control can be performed.
[0158] In invention of claim 10, an accelerometer detects the acceleration of the roll direction of a hull, and the tilt angle of a hull can be computed based on this acceleration, it can consider as a roll angle, and exact control can be performed.
[0159] In invention of claim 11, an inclinometer can detect the tilt angle of the roll direction of a hull, it can consider as a roll angle, and exact control can be performed.
[0160] In invention of claim 12, a magnetometric sensor detects the relative bearing of a hull, this is outputted as whenever [yaw angle], and exact control can be performed.
[0161] It is possible to correspond, also when control of a trim tab can be changed to an automatic and hand control at arbitration, and can be performed in invention of claim 13 and automatic control breaks down.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is structure-of-a-system drawing which looked at the hull which applied the example of this invention from the upper part.
[Drawing 2] It is the block diagram of the controller concerning one example of this invention.
[Drawing 3] It is the graph which shows the general relation between the vessel speed of a ship, and whenever [angle-of-trim].
[Drawing 4] It is the chart showing the control pattern concerning one example of this invention.
[Drawing 5] It is an overall flow chart concerning one example of this invention.
[Drawing 6] It is a flow chart concerning the change of the control method.
[Drawing 7] It is a flow chart concerning tab angle count.
[Drawing 8] It is a flow chart concerning desired value selection.
[Drawing 9] It is a flow chart concerning a tab angle deflection count output.
[Drawing 10] It is the graph which takes effect.
[Description of Notations]
1 Hull
2 Handle
3 Wire
4 Engine
5 Screw
6R, 6L Trim tab
7R, 7L Cylinder (driving means)
8R, 8L Hydraulic motor (driving means)
10 Controller
11 It is Sensor whenever [Yaw Angle].
12 Roll Angle Sensor
13 Transfer Switch
14R, 14L Trim-tab manually-operated switch
15 Speed Sensor
16R, 16L Trim-tab angle sensor

[Translation done.]

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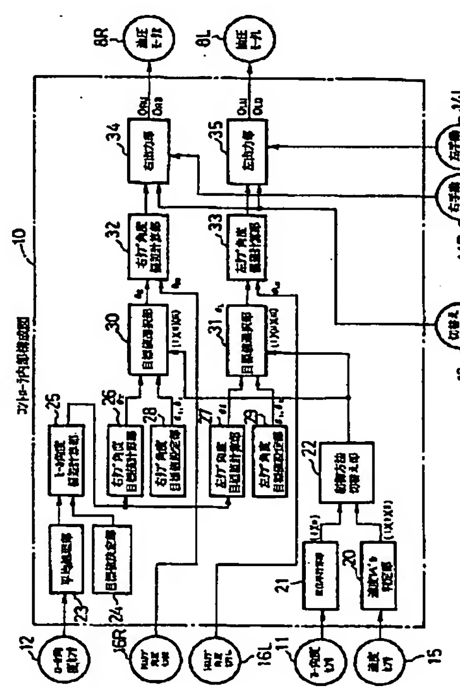
最終頁に続く

(54)【発明の名称】　船舶の自動姿勢制御装置

(57)【要約】

【目的】　船の航行状態に合わせ効率的かつ高精度の姿勢制御を自動的に行なう。

【構成】　トリムタブ（６Ｌ，６Ｒ）と、コントローラ（１０）と、トリムタブ（６Ｒ，６Ｌ）の角度を変える駆動手段（８Ｒ，８Ｌ）と、ロール角度センサ（１２）と、ヨー角度信号センサ（１１）と、速度センサ（１５）と、トリムタブ角度センサ（１６Ｒ，１６Ｌ）とからなり、前記コントローラ（１０）はヨー角度信号と速度信号とより船の航行状態を判定すると共に、航行状態に応じロール角度信号とトリムタブ角度信号とによりトリムタブ６Ｒ，６Ｌの角度を制御することを特徴とする。



【特許請求の範囲】

【請求項１】　船体のロール角度に応じてロール角度信号を出力するロール角度センサと、
船体のヨー角度に応じてヨー角度信号を出力するヨー角度センサと、
船速に応じて速度信号を出力する速度センサと、
船体の姿勢を制御するトリムタブと、
前記センサからの航行条件に応じて信号を出力するコントローラと、
このコントローラに接続し、コントローラから送られてくる出力信号に応じてトリムタブの角度を変える駆動手段と、
からなることを特徴とする船舶の自動姿勢制御装置。

【請求項２】　船体のロール角度に応じてロール角度信号を出力するロール角度センサと、
船体のヨー角度に応じてヨー角度信号を出力するヨー角度センサと、
船速に応じて速度信号を出力する速度センサと、
トリムタブの駆動角度に応じて角度信号を出力するトリムタブ角度センサと、
船体の姿勢を制御するトリムタブと、
前記センサからの航行条件に応じて信号を出力するコントローラと、
このコントローラに接続し、コントローラから送られてくる出力信号に応じてトリムタブの角度を変える駆動手段と、
からなることを特徴とする船舶の自動姿勢制御装置。

【請求項３】　船体の姿勢を制御するトリムタブと、
航行条件に応じて信号を出力するコントローラと、
このコントローラに接続し、コントローラから送られてくる出力信号に応じてトリムタブの角度を変える駆動手段と、
船体のロール角度に応じてロール角度信号を出力するロール角度センサと、
船体のヨー角度に応じてヨー角度信号を出力するヨー角度信号センサと、
船速に応じて速度信号を出力する速度センサと、
トリムタブの駆動角度に応じて角度信号を出力するトリムタブ角度センサとからなり、
前記コントローラは前記ヨー角度信号と前記速度信号とより船の航行状態を判定すると共に、航行状態に応じ前記ロール角度信号と前記トリムタブ角度信号とにより前記トリムタブの角度を制御することを特徴とする船舶の自動姿勢制御装置。

【請求項４】　船体の姿勢を制御するトリムタブと、
航行条件に応じて信号を出力するコントローラと、
このコントローラに接続し、コントローラから送られてくる出力信号に応じてトリムタブの角度を変える駆動手段と、
船体のロール角度に応じてロール角度信号を出力するロール角度センサと、
船体のヨー角度に応じてヨー角度信号を出力するヨー角度センサと、
船速に応じて速度信号を出力する速度センサと、
トリムタブの駆動角度に応じて角度信号を出力するトリムタブ角度センサとからなり、
前記コントローラは前記ヨー角度信号を入力としヨー角度変化率信号を出力する変化率計算部と、速度信号を入力とし速度レベル信号を出力する速度レベル判定部と、前記ヨー角度変化率信号と前記速度レベル信号とを入力とし航行状態の判定を行い制御切り替え信号を出力する制御方法切り替え部とを有し、且つ前記ロール角度信号を平均化しヒール角度信号を出力する平均処理部と、ヒール角度信号とヒール角度目標値信号を入力としヒール角度偏差信号を出力するヒール角度偏差計算部と、ヒール角度偏差信号を入力としトリムタブ角度の目標値を計算するタブ角度目標値計算部と、予め目標とするトリムタブ角度を設定してあるタブ角度目標値設定部とを有し、さらに前記制御方法切り替え信号によりタブ角度目標値の選択を行いタブ角度目標値を出力する目標値選択部と、タブ角度目標値とトリムタブ角度信号とを入力としタブ角度偏差を計算するタブ角度偏差信号とタブ角度偏差信号を入力とし駆動信号を出力する出力部とを有することを特徴とする船舶の自動姿勢制御装置。

【請求項５】　請求項１、又は請求項２、又は請求項３、若しくは請求項４記載の船舶の自動姿勢制御装置であって、
前記コントローラは、前記各センサ信号を入力とし、航行条件に応じてヒール角度制御、旋回時制御、船首浮き上がり状態に於けるトリム角度制御を選択し、各々の制御方法において決定された目標値を出力することを特徴とする船舶の自動姿勢制御装置。

【請求項６】　請求項５記載の船舶の自動姿勢制御装置であって、前記ヒール角度制御は、前記ヨー角度信号と前記速度信号とにより航行状態を判定し、ヒール角度信号と前記トリムタブ角度信号とにより前記トリムタブの角度を制御することを特徴とする船舶の自動姿勢制御装置。

【請求項７】　請求項５記載の船舶の自動姿勢制御装置であって、
前記ヨー角度信号と前記速度信号とより航行状態を判定し、旋回時と判断したとき、トリムタブを予め設定された目標値に制御することを特徴とする船舶の自動姿勢制御装置。

【請求項８】　請求項５記載の船舶の自動姿勢制御装置であって、
前記船首浮き上がり状態に於けるトリム角度制御は、前記速度信号より航行状態を判定し、トリムタブを予め設定された目標値に制御することを特徴とする船舶の自動姿勢制御装置。

【請求項９】　請求項１、請求項２、請求項３、請求項４、請求項５、請求項６、請求項７、請求項８記載の船舶の自動姿勢制御装置であって、
前記ロール角度は、船体のロール方向の角速度を振動ジャイロで検出し、前記角速度を積分して算出することを特徴とする船舶の自動姿勢制御装置。

【請求項１０】　請求項１、請求項２、請求項３、請求項４、請求項５、請求項６、請求項７、請求項８記載の船舶の自動姿勢制御装置であって、
前記ロール角度は、船体のロール方向の加速度を加速度計で検出し、前記加速度に基づき前記船体の傾斜角を算出することを特徴とする船舶の自動姿勢制御装置。

【請求項１１】　請求項１、請求項２、請求項３、請求項４、請求項５、請求項６、請求項７、請求項８記載の船舶の自動姿勢制御装置であって、
前記ロール角度は、船体のロール方向の傾斜角を傾斜計で検出することを特徴とする船舶の自動姿勢制御装置。

【請求項１２】　請求項１、請求項２、請求項３、請求項４、請求項５、請求項６、請求項７、請求項８記載の船舶の自動姿勢制御装置であって、
前記ヨー角度は、船体の相対方位を磁気センサで検出し、これをヨー角度として出力することを特徴とする。船舶の自動姿勢制御装置

【請求項１３】　請求項５記載の船舶の自動姿勢制御装置であって、前記トリムタブを自動的に制御する機構と手動により駆動する機構とを有し、この自動と手動とを任意に切り替え可能であることを特徴とする船舶の自動姿勢制御装置。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】この発明は、モータボートなど、船舶の姿勢を安定させるために、トリムタブの角度を自動的に制御する船舶の自動姿勢制御装置に関する。

【０００２】

【従来の技術】従来の船舶の自動姿勢制御装置としては、例えば特開平３－８２６９７及び特開平３－１１４９９６に示されたものがある。

【０００３】特開平３－８２６９７のものは、操縦量を検出するトルクセンサと、船速を検知する速度センサの出力に応じ、船体の姿勢を検出するピッチ角度センサと、ロール角度センサの出力に応じ、同じくトリムタブ角度を制御する構成である。

【０００４】特開平３－１１４９９６においては、船体の姿勢を検出するピッチ角度センサと、ロール角度センサの出力に応じ、同じくトリムタブ角度を制御する構成になっている。

【０００５】

【発明が解決しようとする課題】しかしながら、特開平３－８２６９７に記載のものは、船体の姿勢そのものを検出せず、略直進時において船速に応じ船首が浮き上がらないようトリムタブの角度を一義的に決定し、また旋回時及び横風等による当て舵実施時において操舵量に応じ船体の横傾斜（ヒール角）を緩和させるようトリムタブの角度を制御する構成となっていたため、次のような問題を招いていた。

【０００６】①略直進時に横傾斜およびローリングを完全には防止できない。

【０００７】②旋回時において、旋回操舵前および旋回操舵中の船体の姿勢に関係せず、トリムタブ角度を制御するのは、船の走行姿勢バランスを崩す要因となるため、有効ではない。

【０００８】また、旋回時において本来遠心力（横加速度）に抗するための有効な姿勢である内傾斜を減ずる方向にトリムタブを制御することは、乗員の体感する横加速度を増大させ、乗員に違和感を与える可能性がある。

【０００９】一方、特開平３－１１４９９６に記載のものは、船の姿勢そのものを表す、ピッチ角度とロール角度を検出し、トリムタブ角度を制御する構成であり、さらに、目標ピッチ角度と目標ロール角度とを与えて比較演算しトリムタブ角度を制御する構成ともなっており、船の航行状態に関係なく常にロール角度とピッチ角度の制御を行っているが、次のような問題があった。

【００１０】③船のヨー角度変化または舵角変化を検出していないため、針路変更のための旋回操舵を検出できなく、やはり旋回時において内傾斜を減ずる方向に制御されてしまう。

【００１１】④常に動揺角を制御しているため、トリムタブを駆動するアクチュエータ（モータ、油圧シリンダ等）の負荷が高くなる。

【００１２】そこで、この発明は、船の航行状態に合わせ効率的かつ高精度の姿勢制御を行なうことのできる船舶の自動姿勢制御装置の提供を目的とする。

【００１３】

【課題を解決するための手段】上記課題を解決するために請求項１の発明は、船体のロール角度に応じてロール角度信号を出力するロール角度センサと、船体のヨー角度に応じてヨー角度信号を出力するヨー角度センサと、船速に応じて速度信号を出力する速度センサと、船体の姿勢を制御するトリムタブと、前記センサからの航行条件に応じて信号を出力するコントローラと、このコントローラに接続し、コントローラから送られてくる出力信号に応じてトリムタブの角度を変える駆動手段と、からなることを特徴とする。

【００１４】請求項２の発明は、船体のロール角度に応じてロール角度信号を出力するロール角度センサと、船体のヨー角度に応じてヨー角度信号を出力するヨー角度センサと、船速に応じて速度信号を出力する速度センサと、トリムタブの駆動角度に応じて角度信号を出力するトリムタブ角度センサと、船体の姿勢を制御するトリムタブと、前記センサからの航行条件に応じて信号を出力

するコントローラとこのコントローラに接続し、コントローラから送られてくる出力信号に応じてトリムタブの角度を変える駆動手段とからなることを特徴とする。

【００１５】請求項３の発明は船体の姿勢を制御するトリムタブと、航行条件に応じて信号を出力するコントローラと、このコントローラに接続し、コントローラから送られてくる出力信号に応じてトリムタブの角度を変える駆動手段と、船体のロール角度に応じてロール角度信号を出力するロール角度センサと、船体のヨー角度に応じてヨー角度信号を出力するヨー角度信号センサと、船速に応じて速度信号を出力する速度センサと、トリムタブの駆動角度に応じて角度信号を出力するトリムタブ角度センサとからなり、前記コントローラは前記ヨー角度信号と前記速度信号とより船の航行状態を判定すると共に、航行状態に応じ前記ロール角度信号と前記トリムタブ角度信号とにより前記トリムタブの角度を制御することを特徴とする。

【００１６】請求項４の発明は船体の姿勢を制御するトリムタブと、航行条件に応じて信号を出力するコントローラと、このコントローラに接続し、コントローラから送られてくる出力信号に応じてトリムタブの角度を変える駆動手段と、船体のロール角度に応じてロール角度信号を出力するロール角度センサと、船体のヨー角度に応じてヨー角度信号を出力するヨー角度センサと、船速に応じて速度信号を出力する速度センサと、トリムタブの駆動角度に応じて角度信号を出力するトリムタブ角度センサとからなり、前記コントローラは前記ヨー角度信号を入力としヨー角度変化率信号を出力する変化率計算部と、速度信号を入力とし速度レベル信号を出力する速度レベル判定部と、前記ヨー角度変化率信号と前記速度レベル信号とを入力とし航行状態の判定を行い制御切り替え信号を出力する制御方法切り替え部とを有し、且つ前記ロール角度信号を平均化しヒール角度信号を出力する平均処理部と、ヒール角度信号とヒール角度目標値信号を入力としヒール角度偏差信号を出力するヒール角度偏差計算部と、ヒール角度偏差信号を入力としトリムタブ角度の目標値を計算するタブ角度目標値計算部と、予め目標とするトリムタブ角度を設定してあるタブ角度目標値設定部とを有し、さらに前記制御方法切り替え信号によりタブ角度目標値の選択を行いタブ角度目標値を出力する目標値選択部と、タブ角度目標値とトリムタブ角度信号とを入力としタブ角度偏差を計算するタブ角度偏差信号とタブ角度偏差信号を入力とし駆動信号を出力する出力部とを有することを特徴とする。

【００１７】請求項５の発明は請求項１、又は請求項２、又は請求項３、若しくは請求項４記載の船舶の自動姿勢制御装置であって、前記コントローラは、前記各センサ信号を入力とし、航行条件に応じてヒール角度制御、旋回時制御、船首浮き上がり状態に於けるトリム角度制御を選択し、各々の制御方法において決定された目標値を出力することを特徴とする。

【００１８】請求項６の発明は請求項５記載の船舶の自動姿勢制御装置であって、前記ヒール角度制御は、前記ヨー角度信号と前記速度信号とにより航行状態を判定し、ヒール角度信号と前記トリムタブ角度信号とにより前記トリムタブの角度を制御することを特徴とする。

【００１９】請求項７の発明は請求項５記載の船舶の自動姿勢制御装置であって、前記ヨー角度信号と前記速度信号とより航行状態を判定し、旋回時と判断したとき、トリムタブを予め設定された目標値に制御することを特徴とする。

【００２０】請求項８の発明は請求項５記載の船舶の自動姿勢制御装置であって、前記船首浮き上がり状態に於けるトリム角度制御は、前記速度信号より航行状態を判定し、トリムタブを予め設定された目標値に制御することを特徴とする。

【００２１】請求項９の発明は請求項１、請求項２、請求項３、請求項４、請求項５、請求項６、請求項７、請求項８記載の船舶の自動姿勢制御装置であって、前記ロール角度は、船体のロール方向の角速度を振動ジャイロで検出し、前記角速度を積分して算出することを特徴とする。

【００２２】請求項１０の発明は請求項１、請求項２、請求項３、請求項４、請求項５、請求項６、請求項７、請求項８記載の船舶の自動姿勢制御装置であって、前記ロール角度は、船体のロール方向の加速度を加速度計で検出し、前記加速度に基づき前記船体の傾斜角を算出することを特徴とする。

【００２３】請求項１１の発明は請求項１、請求項２、請求項３、請求項４、請求項５、請求項６、請求項７、請求項８記載の船舶の自動姿勢制御装置であって、前記ロール角度は、船体のロール方向の傾斜角を傾斜計で検出することを特徴とする。

【００２４】請求項１２の発明は請求項１、請求項２、請求項３、請求項４、請求項５、請求項６、請求項７、請求項８記載の船舶の自動姿勢制御装置であって、前記ヨー角度は、船体の相対方位を磁気センサで検出し、これをヨー角度として出力することを特徴とする。

【００２５】請求項１３の発明は請求項５記載の船舶の自動姿勢制御装置であって、前記トリムタブを自動的に制御する機構と手動により駆動する機構とを有し、この自動と手動とを任意に切り替え可能であることを特徴とする。

【００２６】

【作用】上記手段の請求項１の発明によれば、船体のロール角度、ヨー角度、船速に基づき、コントローラにより駆動手段を制御し、トリムタブの角度を変えることができる。

【００２７】請求項２の発明によれば、船体のロール角度、ヨー角度、船速とトリムタブの角度に基づきコント

ローラが駆動手段を制御し、トリムタブの角度を変えることができる。

【００２８】請求項３の発明によれば、ヨー角度信号と速度信号とより船の航行状態を判定し、航行状態に応じロール角度信号とトリムタブ角度信号とによりトリムタブの角度を制御することができる。

【００２９】請求項４の発明によれば、ヨー角度変化率と速度レベルとを入力して航行状態の判定を行ない、この航行状態の判定に基づき制御方法の切り替えを可能とし、かつロール角度信号を平均化したヒール角度信号とヒール角度目標値信号とによりヒール角度偏差を計算し、このヒール角度偏差信号を入力としてトリムタブ角度の目標値を計算し、また予め目標とするトリムタブ角度を設定し、更に制御方法切り替え信号によりタブ角度目標値の選択を行なってタブ角目標値を出力し、タブ角度目標値とトリムタブ角度信号とを入力してタブ角度偏差を計算し、駆動信号を出力することができる。

【００３０】請求項５の発明によれば、航行状態に応じてヒール角度制御、旋回時制御、船首浮き上がり状態におけるトリムタブ角度制御を選択し、各々の制御方法において決定された目標値を出力することができる。

【００３１】請求項６の発明によれば、ヨー角度信号と速度信号とより航行状態を判定し、ヒール角度信号とトリムタブ角度信号とによりトリムタブの角度を制御してヒール角度制御を行なうことができる。

【００３２】請求項７の発明によれば、ヨー角度信号と速度信号とより航行状態を判定し、旋回時と判断した時トリムタブを予め設定された目標値に設定することができる。

【００３３】請求項８の発明によれば、速度信号により航行状態を判定し、トリムタブを予め設定された目標値に制御することができる。

【００３４】請求項９の発明によれば、船体のロール方向の角速度を振動ジャイロで検出し、角速度を積分してロール角度を算出することができる。

【００３５】請求項１０の発明によれば、船体のロール方向の加速度を加速度計で検出し、この加速度に基づき船体の傾斜角を算出し、ロール角度を求めることができる。

【００３６】請求項１１の発明によれば、船体のロール方向の傾斜角を傾斜計で検出し、ロール角度を求めることができる。

【００３７】請求項１２の発明によれば、船体の相対方位を磁気センサで検出し、これをヨー角度として出力することができる。

【００３８】請求項１３の発明によれば、トリムタブを自動と手動とを任意に切り替えて制御することができる。

【００３９】

【実施例】以下、本発明の実施例を説明する。

【００４０】図１は船体上方から見たシステム構成の全体図である。

【００４１】１は船体、２はハンドルであり、ハンドル２の回転力はワイヤ３を通じスクリュー５を左右に揺動するようにしている。エンジン４には、エンジン４によって回転力を与えられる前記スクリュー５を接続している。ハンドル２の回転によってスクリュー５を左右に揺動することによって、推力の方向を変化させ、船体を旋回させるようにしている。

【００４２】コントローラ１０には、船首の左右方向への振れ角度を検出するヨー角度センサ１１と船体の左右方向の動揺角を検出するロール角度センサ１２と船体の速度を検出する速度センサ１５とを接続している。なお、ロール角度は船体へのロール方向の角速度を振動ジャイロで検出し前記角速度を積分して算出することができる。また、船体のロール方向の加速度を加速度計で検出しこの加速度に基づき船体の傾斜角を算出することにより求めることができる。更にロール角度は船体のロール方向の傾斜角を傾斜計で検出することにより求めることができる。ヨー角度は船体の相対方位を磁気センサで検出し、これをヨー角度として出力することができる。

【００４３】前記ヨー角度センサ１１で検出したヨー角度信号ωとロール角度センサ１２で検出したロール角度信号ϕと速度センサ１５で検出した速度信号vはそれぞれコントローラ１０に入力するようにしている。

【００４４】また、コントローラ１０には、トリムタブ６Ｒ，６Ｌの角度を検出する角度センサ（右トリムタブ用１６Ｒ、左トリムタブ用１６Ｌ）とトリムタブ６Ｒ，６Ｌを自動制御するかまたは手動操作するかを切り換える切り換えスイッチ１３とトリムタブ６Ｒ，６Ｌを手動操作するための手動操作スイッチ（右トリムタブ用１４Ｒ、左トリムタブ用１４Ｌ）を接続している。

【００４５】さらに、コントローラ１０は、電源スイッチ１７を介してバッテリ９と接続している。電源スイッチ１７がＯＦＦの場合、コントローラ１０の作動が停止する構成になっている。

【００４６】コントローラ１０は、コントローラ１０から出力される信号に応じてトリムタブ６Ｒ、６Ｌの角度を変える駆動手段にその出力を接続している。

【００４７】この実施例のトリムタブ６Ｒ、６Ｌの駆動手段は、次のように構成されている。コントローラ１０からの出力信号に応じて、油圧モータ８Ｒ、８Ｌを正転、反転させている。油圧モータ８Ｒ、８Ｌの正転、反転に応じシリンダ７Ｒ、７Ｌは伸縮運動を行う。このシリンダ７Ｒ、７Ｌの伸縮運動によりトリムタブ６Ｒ、６Ｌを上下動するようにしている。

【００４８】次に、図２によりコントローラ１０の内部構成について説明する。

【００４９】コントローラ１０には、まず前記速度センサ１５から速度信号vが入力され、この速度信号ｖは速

度レベル判定部２０へ送られる。

【００５０】この速度レベル判定部２０には、予め内部に航行状態を判定するための一定値 v_1 ，v_2 （v_1 ．＜ v_2 ）が設定される。v_1 はアイドリング状態と船の船首浮き上がり状態との境界値である。v_2 は船首浮き上がり状態とプレーン状態との境界値である。この v_1 ，v_2 の値は船の航行条件や船体の特性に応じ、任＊＊意の値に設定できる。

【００５１】なお、船速とトリム角との関係は、一般に図３に示されるような特性がある。

【００５２】前記速度レベル判定部２０では、次の判定式により船の速度レベルを次の３通りに区分する。

【００５３】

(1)　$v < v_1$　（アイドリング状態）
(2)　$v_1 \leqq v \leqq v_2$　（船首浮き上がり状態）
(3)　$v_2 < v_1$　（プレーン状態）　…第１式

(1)の条件のとき (1)信号を制御方法切替え部２２に出力する。

【００５４】(2)の条件のとき (2)信号を制御方法切替え部２２に出力する。

【００５５】(3)の条件のとき (3)信号を制御方法切替え部２２に出力する。

【００５６】またコントローラ１０に前記ヨー角度センサ１１からヨー角度信号 υ が入力されるとこのヨー角度信号 ω は変化率計算部２１へ送られる。※

※【００５７】この変化率計算部２１においては、入力されたヨー角度信号 ω に応じて単位時間毎のヨー角度変化であるヨー角度変化率 $d\omega/dt$ を計算する。そして、計算されたヨー角度変化率 $d\omega/dt$ は、変化率計算部２１は予め設定されている一定値 $d\omega o/dt$ と比較演算し出力信号を選択する。 $d\omega o/dt$ は船の航行状態が現在、直進時か旋回時かを判断する境界値である。この $d\omega o/dt$ の値は船の航行条件や船体の特性に応じ、任意の値に設定できる

（イ）　$d\omega/dt < d\omega o/dt$　(直進時)
（ロ）　$d\omega/dt \geqq d\omega o/dt$　(旋回時)　…第２式

（イ）の条件の時は（イ）信号を制御方法切替え部２２に出力する。

【００５８】（ロ）の条件の時は（ロ）信号を制御方法切替え部２２に出力する。

【００５９】前記の速度レベル判定部２０からの速度レベル信号と前記の変化率計算部２１からの変化率信号とを制御方法切替え部２２に入力すると、制御方法切替え部２２では、入力された速度レベル信号と変化率信号との組み合わせにより、図４に示すような命令信号(i) ～(iii) を決定し、目標値選択部３０，３１に出力する。

【００６０】切り替え命令信号(i) ～(iii) は、
(i) トリムタブを最も上に上げた状態にする命令信号
(ii)トリムタブを最も下に下げた状態にする命令信号
(iii) ヒール角度制御を行う命令信号
を意味する。

【００６１】すなわち、第１式における船の速度レベルがアイドリング状態と判定された場合は、第２式における直進時および旋回時判定の如何に関わらず、切替え命令信号(i) すなわちトリムタブを最も上にあげた状態に制御する。

【００６２】また、第１式における速度レベルが船首浮き上がり状態（プレーン移行前の走行状態）と判定した場合、第２式における直進時および旋回時判定の如何に関わらず、切替え命令信号(ii)すなわちトリムタブ６Ｒ，６Ｌを最も下げた状態に制御する。

【００６３】これは、前述した様にプレーン状態に移行するまでは船首を下げる制御が有効であり、この状態でのローリング制御およびヒール角度制御は有効性が少ないことによる。

【００６４】さらに、第１式における速度レベルがプレーン状態と判定された場合は、第２式にて直進時と判定された場合に切替え命令信号(iii) すなわちヒール角度制御を実施、旋回時と判定された場合は切替え命令信号(i) すなわちトリムタブ６Ｒ，６Ｌを最も上げた状態に制御する。

【００６５】これにより、直進時プレーン状態のみヒール角度制御を実施し、旋回時には本来船の有する特性である横傾斜を阻害しないよう制御する。

【００６６】一方、コントローラ１０にはロール角度センサ１２からロール角度信号 ϕ が入力され、このロール角度信号 ϕ は平均処理部２３に送られる。

【００６７】この平均処理部２３では、入力されたロール角度信号 ϕ に対し、次の第３式の計算を行い移動平均値を求める。この移動平均値をヒール角度 ϕa とする。

【００６８】

【数１】

$$\phi ak = \frac{1}{n'} \sum_{i=k-n'}^{k} \phi i$$ …第３式

ここで i は $(k-n')$, $(k-n'+1)$, $(k-n'+2)$, ……, k

$\{K-(k-n'+n')\}$

φｉはｉ時点でのロール角度
φａｋはｋ時点でのヒール角度を示す。
【００６９】φａｋはすなわちφｉをｎ’回足した値の平均値である。
【００７０】φは進行方向に対し右傾斜方向を正とする。
【００７１】第３式により計算したヒール角度φａを出力信号とし、ヒール角偏差計算部２５に出力する。
【００７２】このヒール角偏差計算部２５には、この他に目標値決定部２４において予め設定されている目標ヒール角度を示す目標ヒール角度信号φo も入力している。
【００７３】このヒール角偏差計算部２５では、次の第４式の計算を行ないヒール角度偏差信号φｅを求める。
【００７４】

$$\phi e = \phi a - \phi o$$ …第４式

ここで、船体が進行方向に対して右廻り方向を正とする。
【００７５】このヒール角度偏差信号φｅはタブ角度目標値計算部２６，２７へ出力される。
【００７６】タブ角度目標値計算部２６では、入力されたヒール角度偏差信号φｅをもとに、φｅの正負を判断したうえで、第５式のＰＩＤ演算を行い、右のトリムタブのタブ角度目標値θｒを求める。
【００７７】
【数２】

$\phi e \geqq 0$ なら

$$\theta r = K_p \phi_e + T_D \frac{d}{dt} \phi_e + \frac{1}{T_I} \int \phi_e \, dt$$ …第５式

$\phi e < 0$ なら

$$\theta r = 0$$

ここで、K_p, T_D, T_I は定数である。

タブ角目標値計算部２７では、入力されたヒール角度偏差信号φｅをもとに、φｅの正負を判断したうえで、次の第６式のＰＩＤ演算を行い、左のトリムタブ６Ｌのタブ角目標値θ_lを求める。
【００７８】
【数３】

$\phi e \geqq 0$ なら

$$\theta \ell = 0$$

$\phi e < 0$ なら

$$\theta \ell = -\left(K_p \phi_e + T_D \frac{d}{dt} \phi_e + \frac{1}{T_I} \int \phi_e \, dt\right) \quad \cdots 第6式$$

ここで、K_p，T_D，T_I は定数である。

なお第５式並びに第６式の第１項Ｋｐφｅはヒール角度偏差信号φｅに比例したタブ角度を与える。すなわち、ヒール角度偏差信号φｅの絶対値が大きいほど、右または左のタブ角度を大きくするものである。

【００７９】同第２項は、ヒール角度偏差信号φｅの微分値に比例したタブ角度を与えるものであり、この微分値が大きくなければその分大きなタブ角度を与え、船体のヒール角度を減少させる応答性を向上させている。

【００８０】同第３項は、ヒール角度偏差信号φｅの積分値に比例したタブ角度を与えるものであり、これは船体の特性や外力によって生じた定常的な船体の横傾斜（ヒール角度）を打ち消すタブ角度を与えている。

【００８１】ここで求められた、右タブ角目標値θｒは目標値選択部３０に出力される。また左タブ目標値θ_lは目標値選択部３１に出力される。

【００８２】以下に右トリムタブの出力信号決定までの説明を行う。左トリムタブの出力信号決定までの流れは右トリムタブとまったく同じであり、説明は省略する。

【００８３】目標選択部３０へは、前記した制御方法切替え部２２から出力される切替え命令信号(i)～(iii)と、右タブ角度目標値計算部２６から出力されるタブ角度目標値θｒが入力されるが、その他に予め目標タブ角＊を設定した右タブ角目標値設定部２８から目標設定値θ_1，θ_2を入力している。目標設定値θ_1はトリムタブ６Ｒを最も上げた状態の設定値である。目標設定値θ_2はトリムタブ６Ｒを最も下げた状態の設定値である。

【００８４】目標値選択部３０では切替え命令信号(i)～(iii)に対応し、右タブ角度の目標値θ_r，θ_1，θ_2を選択する。選択対応は以下の通りである。

【００８５】

切り替え命令信号	タブ角目標値
(i)　のとき	θ_1 を選択
(ii)　のとき	θ_2 を選択
(iii)　のとき	θ_r を選択

これにより選択された右タブ角度目標値を$\theta_R = \theta_1$・又はθ_2、又はθ_rとする。

【００８６】目標値選択部３０で選択された右タブ角度目標値θ_Rは、右タブ角偏差計算部３２へ出力される。

【００８７】右タブ角偏差計算部３２へは、入力されたタブ角目標値θ_Rの他に、トリムタブ角度センサ１６Ｒで検出された角度信号θ_{Ro}も入力されている。

【００８８】右タブ角偏差計算部３２では、次の第７式の計算を行い、偏差角度θ_eを求める

$$\theta_e = \theta_R - \theta_{Ro} \quad \cdots 第7式$$

さらにθ_eの正負判別を行い、偏差角θ_eが零になるようにトリムタブ６Ｒをアップ・ダウンさせる信号を以下のように決定する。

【００８９】

θ_eが正のときは	ダウン信号（O_{RD}）
θ_eが負のときは	アップ信号（O_{RU}）

このアップ・ダウン信号は右出力部３４に出力される。

【００９０】右出力部３４では、右タブ角偏差計算部３２で決定されたアップ・ダウン信号O_{RU}又はO_{RD}を入力とする他に、切替えスイッチ１３からオン・オフ信号を出力とする切替え信号と右の手動スイッチ１４Ｒからの手動信号とを入力している。

【００９１】すなわち、右出力部３４では、切替えスイッチ１３から入力する切替え信号により、自動、手動のトリムタブ制御を切り替えられるようにしている。

【００９２】切替えスイッチ１３がオンの場合は自動とし、上記で決定されたアップ・ダウン信号O_{RD}又はO_{RU}を出力信号として油圧モータ８Ｒに出力する。

【００９３】切替えスイッチ１３がオフの場合は手動とし、右手動スイッチ１４Ｒの操作により決定されるアップ・ダウン信号を右出力部３４の出力として油圧モータ８Ｒへ出力される。

【００９４】以上右トリムタブ６Ｒの制御について説明したが、左トリムタブ６Ｌも同じである。

【００９５】ここで、滑走艇において、プレーン状態に入るまでの間は船尾の喫水が深いため船底にかかる水圧が増し、ローリングは少ない。一方、この間は船尾の沈み込みにより船首が上がり前方視界が悪化すると共に、プレーンへの移行が遅くなるため、従来よりトリムタブを左右共降ろすことにより船首を下げる操作が行われており、本発明の実施例の制御もこれに準ずる。

【００９６】これに対しプレーン状態においては喫水が浅くなり船の動揺が活発になる。この状態においてローリングとピッチングを比較した場合、通常ピッチング周期の方が長く、ローリングの方が敏感に体感される。またトリムタブを用いた姿勢制御はその構造上、上がりすぎた船首を下げる効果は期待できるものの、下がりすぎた船首を持ち上げる効果は無い。よってプレーン状態における姿勢制御はローリングの抑制がより有効である。

【００９７】しかしながら全てのローリングを常に抑制することは、制御アクチュエータに多大な負荷を与えることとなるため、本発明の実施例では船体の動揺角（ローリング）そのものを押えようとするものでなく、その平均的な姿勢角（これをヒール角という）を制御する。

【００９８】また、旋回時におけるローリング制御の無効性については前述の通りであるが、旋回状態の検出には、直進、旋回時各々におけるヨー角度変化率のレベルが異なることを利用している。すなわちヨー角度変化率があるレベルを越えると旋回と判断することができる。

【００９９】次に上記コントローラ１０の制御作用を図５から図９のフローチャートに基づいて説明する。なお、この説明においても、右トリムタブ６Ｒの制御について行ない、左トリムタブ６Ｌの制御は省略する。

【０１００】まず、図５のように全体的な制御が行われる。即ちステップＳ１において制御方法の切り替えが行われる。この制御方法の切り替えは、前記命令信号(i)、命令信号(ii)、命令信号(iii) の切替えである。

【０１０１】ステップＳ２ではタブ角度計算が行われる。タブ角度計算は前記ロール角度センサ１２（図１）の検出に基づいて行われる。

【０１０２】ステップＳ３では目標値選択が行われる。目標値選択は航行状態に応じてタブ角度 θ_r ， θ_1 ， θ_2 の選択を行なう。

【０１０３】ステップＳ４ではタブ角度偏差計算及び出力が行われる。タブ角度偏差計算は選択された目標値 θ_R とトリムタブ角度センサ１６Ｒ（図１）で検出されたトリムタブ角度とに基づき計算される。出力は偏差が０となるようにアップまたはダウンの信号を油圧モータ８Ｒに出力する。

【０１０４】次に、ステップＳ１～Ｓ４の詳細について説明する。

【０１０５】前記ステップＳ１の制御方法の切り替えは図６のルーチンによって行われる。まずステップＳ１０１では速度センサ１５（図１）で検出した速度ｖの読み込みが行われる。

【０１０６】ステップＳ１０２では速度レベルの判定が行われる。この判定は、速度レベル判定部２０（図１）で行なわれ、前記したように

(1) $v < v_1$

(2) $v_1 \leqq v \leqq v_2$

(3) $v_2 < v$

について行なわれ、$v < v_1$ の場合はステップＳ１０３で(1) 信号の選択が行われる。

【０１０７】$v_1 \leqq v \leqq v_2$ の場合はステップＳ１０４で(2) 信号の選択が行われる。

【０１０８】$v_2 < v$ の場合はステップＳ１０５において(3) 信号の選択が行われる。

【０１０９】ついでステップＳ１０６においてヨー角度センサ１１（図１）で検出されたヨー角度ωの読み込みが行われる。

【０１１０】ステップＳ１０７では、航行状態の判断が行われる。この判断は、変化率計算部２１（図１）で行なわれ、前記したように

（イ）$d\omega/dt < d\omega 0/dt$

（ロ）$d\omega/dt \geqq d\omega 0/dt$

について行なう。

【０１１１】$d\omega/dt < d\omega 0/dt$ の場合はステップＳ１０８において（イ）信号の選択が行われる。

【０１１２】$d\omega/dt \geqq d\omega 0/dt$ の場合はステップＳ１０９で（ロ）信号の選択が行われる。これらの信号選択が行われたら、これらの信号に基づきステップＳ１１０において速度及び航行状態の判断が行われる。この判断は制御方法切替部２２において前記図４のように行われる。

【０１１３】即ち、(1) 及び（イ）、(1) 及び（ロ）、(3) 及び（ロ）の場合はステップＳ１１１において(i) 信号の選択が行われる。

【０１１４】(2) 及び（イ）、(2) 及び（ロ）の場合はステップＳ１１２において(ii)信号の選択が行われる。

【０１１５】(3) 及び（イ）の場合はステップＳ１１３において(iii) 信号の選択が行なわれる。

【０１１６】これら(i) 信号、(ii)信号、(iii) 信号によって制御方法の切替えを判断することができる。従ってステップＳ１１４において(i) 、又は(ii)、若しくは(iii) の選択された切替え信号が出力される。

【０１１７】次に前記図５のステップＳ２のタブ角度計算は図７のルーチンによって行なわれる。まずステップＳ２０１において検出ロール角φの読み込みが行なわれる。この読み込みは前記ロール角度センサ１２（図１）の検出に基づいている。

【０１１８】次いでステップＳ２０２において移動平均値φａの計算が行なわれる。この平均処理は平均処理部２３（図１）で行なわれる。移動平均値φａは前記したようにヒール角度として出力されるものである。

【０１１９】ステップＳ２０３において決定目標地ϕ_oの読込みが行なわれる。この決定目標地ϕ_oは前記目標値決定部２４（図１）において予め決定されている値に基づいている。

【０１２０】ステップＳ２０４ではヒール角度偏差計算が行なわれる。このヒール角度偏差計算は、ヒール角度計算部２５（図１）で行なわれ、

$\phi_e = \phi_a - \phi_o$

を実行する。

【０１２１】ステップＳ２０５ではタブ角度目標値θ_rの計算が行なわれる。この計算は前記したように右タブ角度目標値計算部２６（図１）で行なわれる。

【０１２２】次にステップＳ２０６においてタブ角度θ_rの出力が行なわれる。この出力は右タブ角度目標値計算部２６から目標値選択部３０へ行なう。

【０１２３】前記図５のステップＳ３の目標値選択は図８のルーチンに基づいて行なわれる。このルーチンは目標値選択部３０（図１）によって実行される。

【０１２４】まずステップＳ３０１でタブ角度計算目標値θ_rの読込みが行なわれる。この目標値θ_rは前記目標値計算部２６（図１）からの出力に基づいている。

【０１２５】ステップＳ３０２ではタブ角度設定目標値θ_1、θ_2の読込みが行なわれる。この目標値θ_1、θ_2は右タブ角度目標値設定部２８（図１）からの出力に基づいている。

【０１２６】ステップＳ３０３では切替え信号(i)、(ii)、(iii)の読込みが行なわれる。この読込みは前記制御方法切替え部２２からの出力に基づいている。

【０１２７】ステップＳ３０４では切替え信号の判断が行なわれる。(i)の場合はステップＳ３０５において目標値θ_1の選択が行なわれる。(ii)の場合はステップＳ３０６において目標値θ_2の選択が行なわれる。(iii)の場合はステップＳ３０７において目標値θ_rの選択が行なわれる。これら選択された目標値θ_1、θ_2、θ_rのいずれかが目標値θ_RとしてステップＳ３０８において出力される。この出力は前記目標値選択部３０から右タブ角度偏差計算部３２へ行なわれる。

【０１２８】前記図５のステップＳ４のタブ角度偏差計算出力は図９のルーチンによって行なわれる。このルーチンは前記右タブ角度偏差計算部３２と右出力部３４とによって行なわれる。

【０１２９】まずステップＳ４０１において選択した目標値θ_1、θ_2、θ_rの読込みが行なわれる。この読込みは目標値選択部３０（図１）からの出力に基づいている。

【０１３０】ステップＳ４０２では検出したトリムタブ角θ_{RO}の読込みが行なわれる。この読込みは前記トリムタブ角度センサ１６Ｒ（図１）からの出力に基づいている。

【０１３１】ステップＳ４０３ではタブ角偏差計算が行なわれる。この計算は

$\theta_e = \theta_R - \theta_{RO}$

を実行する。

【０１３２】次いでステップ４０４においてθ_eの正負判定が行なわれる。θ_eが正の場合はステップＳ４０５においてダウン信号O_{RD}の出力が行なわれる。θ_eが負の場合はステップＳ４０６においてアップ信号O_{RU}が出力される。この出力によって前記油圧モータ８Ｒが駆動され、トリムタブ角がダウン側又はアップ側に制御される。

【０１３３】そしてステップＳ４０７において$\theta_e = 0$か否かの判断が行なわれ、０になったら制御を終了する。

【０１３４】このように船の航行状態に合わせてトリムタブ６Ｒ，６Ｌを制御することができ、効率的かつ高精度の姿勢制度を自動的に行なうことができる。また、油圧モータ８Ｌ，８Ｒの負荷を最小にして耐久性及び信頼性を向上することができる。

【０１３５】図１０に本発明の上記実施例による効果の一例を示す。

【０１３６】図１０(a)は、直進時に横風を受けた状態における、船の速度毎におけるヒール角度抑制効果を示す。

【０１３７】図中の実線は本発明実施例による制御の場合、破線は未制御の場合、二点鎖線は全域にわたりローリング制御を行った場合をそれぞれ示す。

【０１３８】これらから明らかなように、横風等の外乱に対し本発明実施例は非常に有効なヒール角度抑制効果を有していることがわかる。

【０１３９】また、ヒール角度未制御のプレーニング前の領域での傾きは前記した通り小さいため人間が不快感を感じる程度ではなく、この領域では制御効果が少ないこともわかる。

【０１４０】図１０(b)は、同様に本発明によるトリム抑制効果を示す。図中の実線は本発明による制御の場合、破線は未制御の場合、二点鎖線は全域にわたりピッチング制御を行った場合をそれぞれ示す。

【０１４１】これらから明らかなように、本発明実施例によりプレーニング前のトリム抑制制御による船首浮き上がり防止効果が得られるだけでなく、トリム抑制未制御領域であるプレーニング後においてもトリム抑制効果が継続することが良くわかる。

【０１４２】また低速域および最高速域においてトリム抑制制御を行っても、効果が小さいことも良くわかる。

【０１４３】以上、上記実施例の構成、制御ロジック、作用、効果について説明したが、本発明は上記実施例の構成および制御ロジックに限定されるものではない。

【０１４４】例えば、第５式および第６式における各第２項および各第３項については制御精度を高めるための補正項であり、これらいずれかまたは双方を省略するこ

とも可能である。

【０１４５】また、タブ角偏差計算部３２，３３において第７式により偏差角度θ_eを求めた上で出力部３４，３５にトリムタブのアップ・ダウン信号を出力して駆動しているが、目標値選択部３０，３１で選択されたタブ角目標値そのものでトリムタブを駆動することも可能である。

【０１４６】この場合、タブ角偏差計算部３２，３３およびトリムタブ角度センサー１６Ｒ，１６Ｌが省略可能となる。

【０１４７】またこの構成において制御後のロール角との比較演算を行い、学習による偏差のフィードバック等も可能であることは言うまでもない。

【０１４８】実施例中の各センサについても、前記制御が可能であれば固有の物に限定されず、また１つで複数の機能を有する物であっても良いことは言うまでもない。

【０１４９】

【発明の効果】以上より明らかなように請求項１の発明によればトリムタブの制御を船体のロール角度、ヨー角度、船速に応じて自動制御することができ高精度の姿勢制御を自動的に行なうことができる。

【０１５０】請求項２の発明によればトリムタブの制御をロール角度、ヨー角度、船速と検出したトリムタブ角度に応じて自動制御することができ、より高精度の姿勢制御を自動的に行なうことができる。

【０１５１】請求項３の発明によればヨー角度信号と速度信号とより船の航行状態を判定し、これによってトリムタブの角度を制御することができる。従って、船の航行状態に合わせ効率的かつ高精度の姿勢制御を自動的に行なうことができる。

【０１５２】請求項４の発明によればヨー角度変化率、速度レベル判定に基づいて航行状態の判定を行ない制御方法の切替えを行なうことができる。そして制御方法の切替え信号によりタブ角度目標値の選択を行い駆動信号を出力することができる。従ってより高精度の姿勢制御を自動的に行なうことができる。

【０１５３】請求項５の発明では航行条件に応じて選択したヒール角度制御、旋回時制御、船首浮き上がり状態におけるトリム角度制御において決定された目標値を出力し航行条件に応じた制御を適確に行なうことができる。

【０１５４】請求項６の発明ではヨー角度信号と速度信号とより航行状態を判定しヒール角度信号とトリムタブ角度信号とによりトリムタブの角度を制御することができ、より適確な制御を行なうことができる。

【０１５５】請求項７の発明によれば旋回時と判断したときトリムタブを予め設定された目標値に制御し旋回時の制御をより適確に行なうことができる。

【０１５６】請求項８の発明によれば船首浮き上がり状態におけるトリム角度制御を適確に行なうことができる。

【０１５７】請求項９の発明によれば船体のロール方向の角速度を振動ジャイロで検出し、角速度を積分してロール角度を算出し正確な制御を行なうことができる。

【０１５８】請求項１０の発明では船体のロール方向の加速度を加速度計で検出し、この加速度に基づき船体の傾斜角を算出してロール角度とし、正確な制御を行なうことができる。

【０１５９】請求項１１の発明では船体のロール方向の傾斜角を傾斜計で検出してロール角度とし正確な制御を行なうことができる。

【０１６０】請求項１２の発明では船体の相対方位を磁気センサで検出し、これをヨー角度として出力して正確な制御を行なうことができる。

【０１６１】請求項１３の発明ではトリムタブの制御を、自動と手動とに任意に切替えて行なうことができ自動制御が故障した場合にも対応することが可能である。

【図面の簡単な説明】

【図１】この発明の実施例を適用した船体を上部から見たシステムの構成図である。

【図２】この発明の一実施例に係るコントローラの構成図である。

【図３】船の船速とトリム角度との一般的な関係を示すグラフである。

【図４】この発明の一実施例に係る制御パターンを示す図表である。

【図５】この発明の一実施例に係る全体的なフローチャートである。

【図６】制御方法の切替えに係るフローチャートである。

【図７】タブ角度計算に係るフローチャートである。

【図８】目標値選択に係るフローチャートである。

【図９】タブ角度偏差計算出力に係るフローチャートである。

【図１０】効果を示すグラフである。

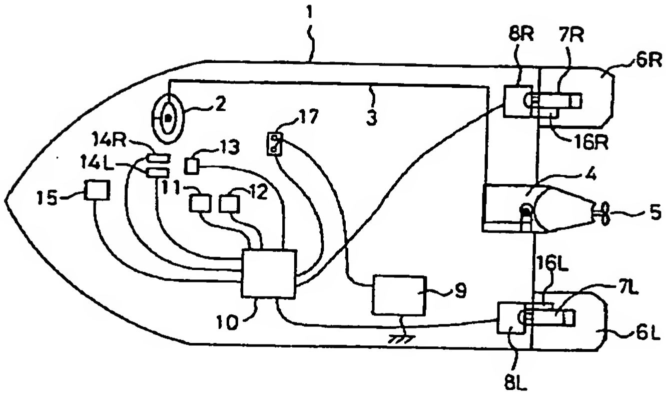
【符号の説明】

１　船体
２　ハンドル
３　ワイヤ
４　エンジン
５　スクリュー
６Ｒ，６Ｌ　トリムタブ
７Ｒ，７Ｌ　シリンダ（駆動手段）
８Ｒ，８Ｌ　油圧モータ（駆動手段）
１０　コントローラ
１１　ヨー角度センサ
１２　ロール角度センサ
１３　切り換えスイッチ
１４Ｒ，１４Ｌ　トリムタブ手動操作スイッチ

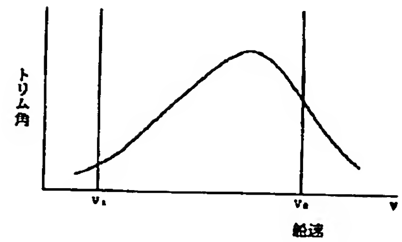
１５　速度センサ

１６Ｒ，１６Ｌ　トリムタブ角度センサ

【図１】



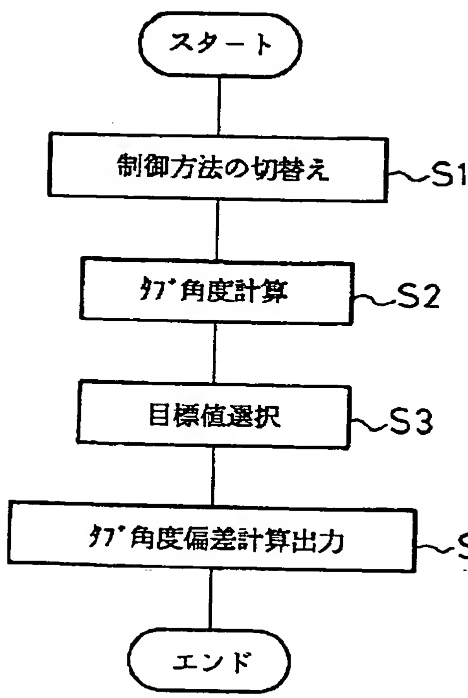
【図３】



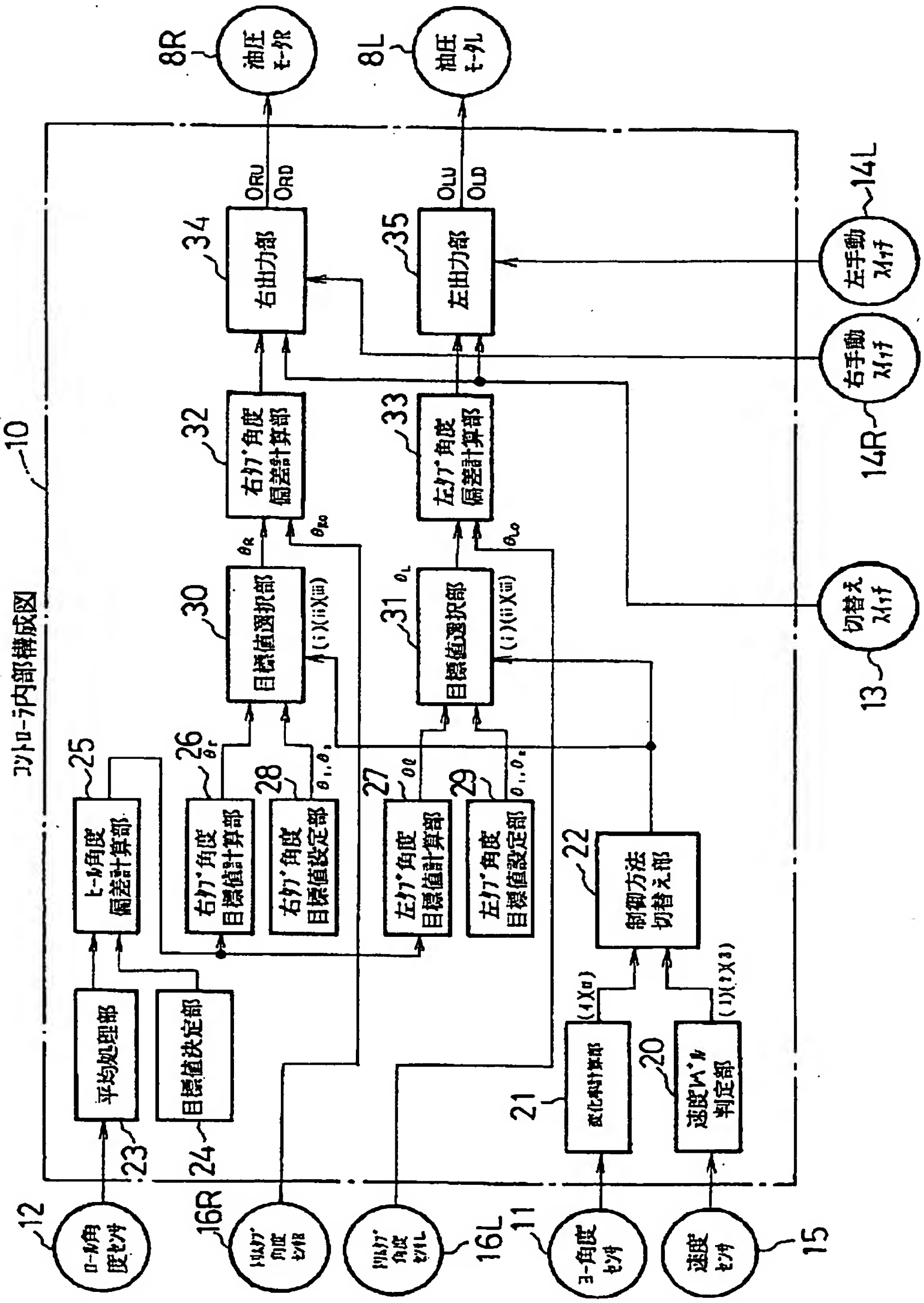
【図４】

ブレーキ状態判定部出力信号	変化率計算部出力信号	制御方法切替え部出力信号
(1)	(イ)	(i)
	(ロ)	(i)
(2)	(イ)	(ii)
	(ロ)	(ii)
(3)	(イ)	(iii)
	(ロ)	(i)

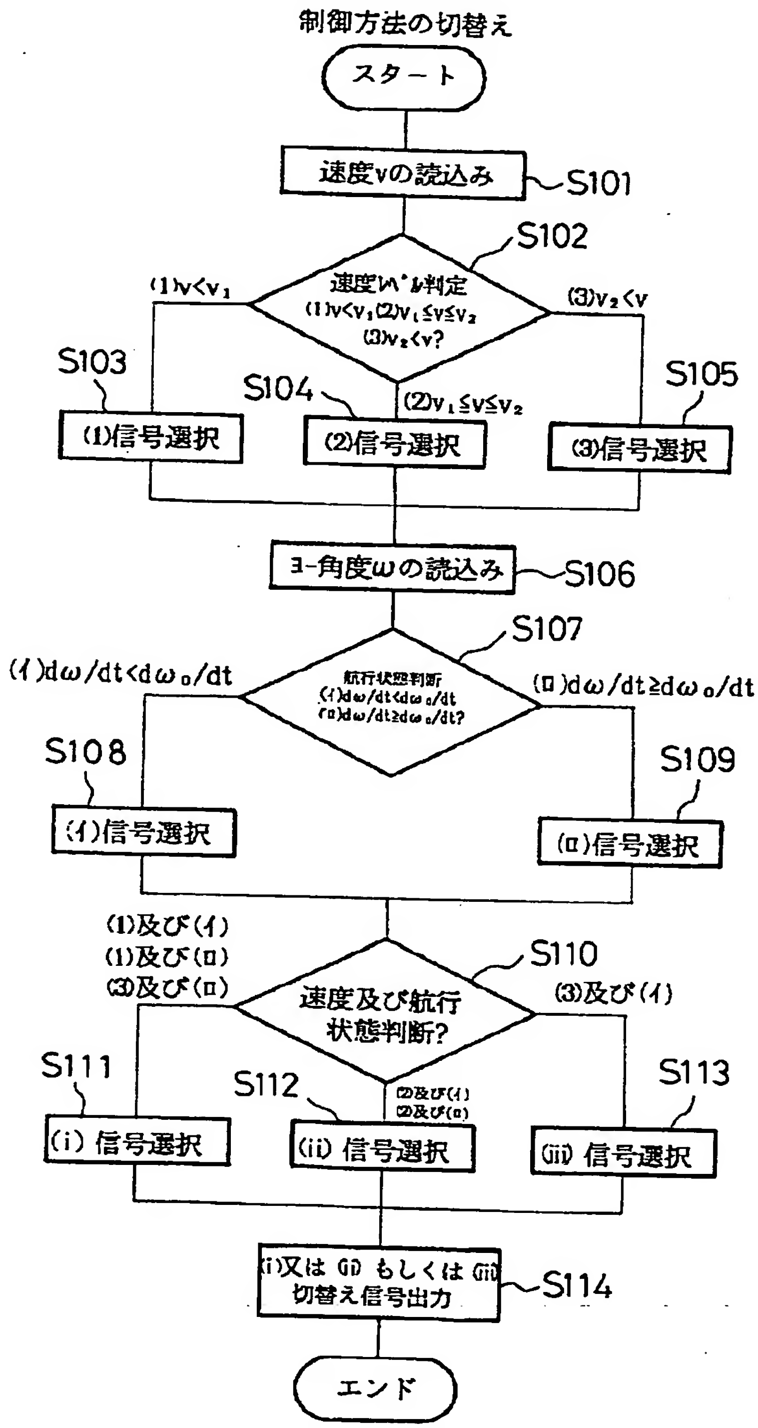
【図５】



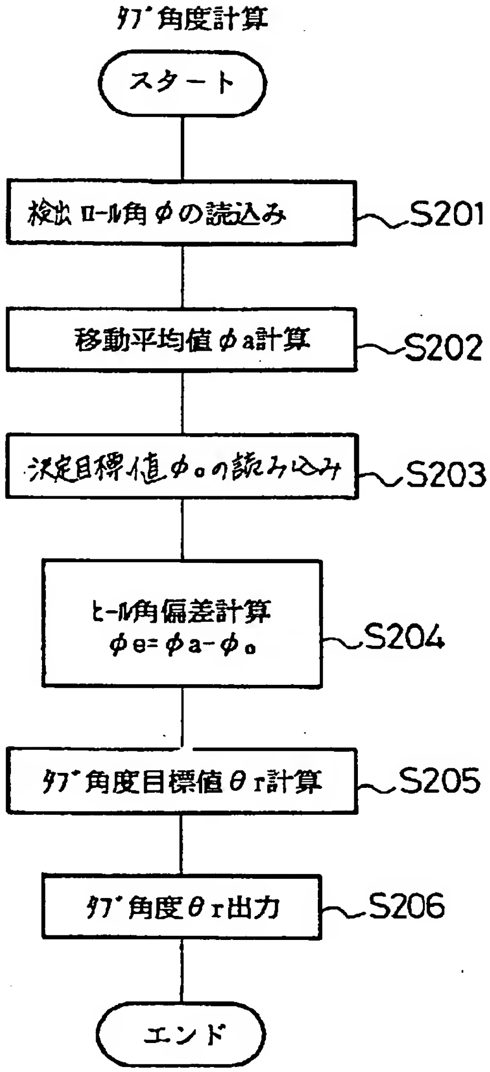
【図２】


コントローラ内部構成図
10
12 ロール角度センサ
16R リムガード角度センサR
16L リムガード角度センサL
11 ヨー角度センサ
15 速度センサ
23 平均処理部
24 目標値決定部
25 ヒール角度偏差計算部
26 右ガード角度目標値計算部
28 右ガード角度目標値設定部
27 左ガード角度目標値計算部
29 左ガード角度目標値設定部
21 変化量計算部
20 速度レベル判定部
22 制御方法切替え部
30 目標値選択部
31 目標値選択部
32 右ガード角度偏差計算部
33 左ガード角度偏差計算部
34 右出力部
35 左出力部
13 切替えスイッチ
14R 右手動スイッチ
14L 左手動スイッチ
8R 油圧モータR
8L 油圧モータL

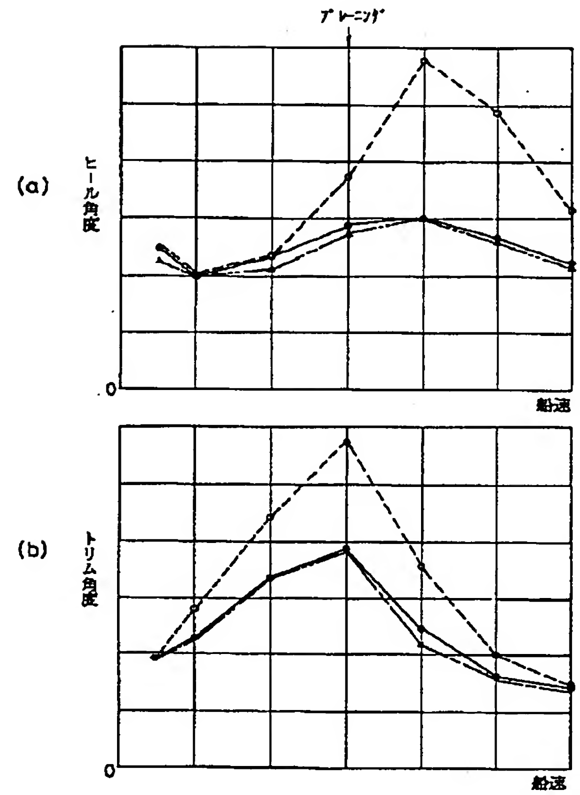
【図6】


制御方法の切替え
スタート
速度vの読込み
S101
S102
速度レベル判定
(1)v<v1 (2)v1≦v≦v2
(3)v2<v?
(1)v<v1
(2)v1≦v≦v2
(3)v2<v
S103
S104
S105
(1)信号選択
(2)信号選択
(3)信号選択
ヨー角度ωの読込み
S106
S107
航行状態判断
(イ)dω/dt<dω0/dt
(ロ)dω/dt≧dω0/dt?
(イ)dω/dt<dω0/dt
(ロ)dω/dt≧dω0/dt
S108
S109
(イ)信号選択
(ロ)信号選択
S110
速度及び航行状態判断?
(1)及び(イ)
(1)及び(ロ)
(3)及び(ロ)
(3)及び(イ)
(2)及び(イ)
(2)及び(ロ)
S111
S112
S113
(i) 信号選択
(ii) 信号選択
(iii) 信号選択
(i)又は (ii) もしくは (iii)
切替え信号出力
S114
エンド

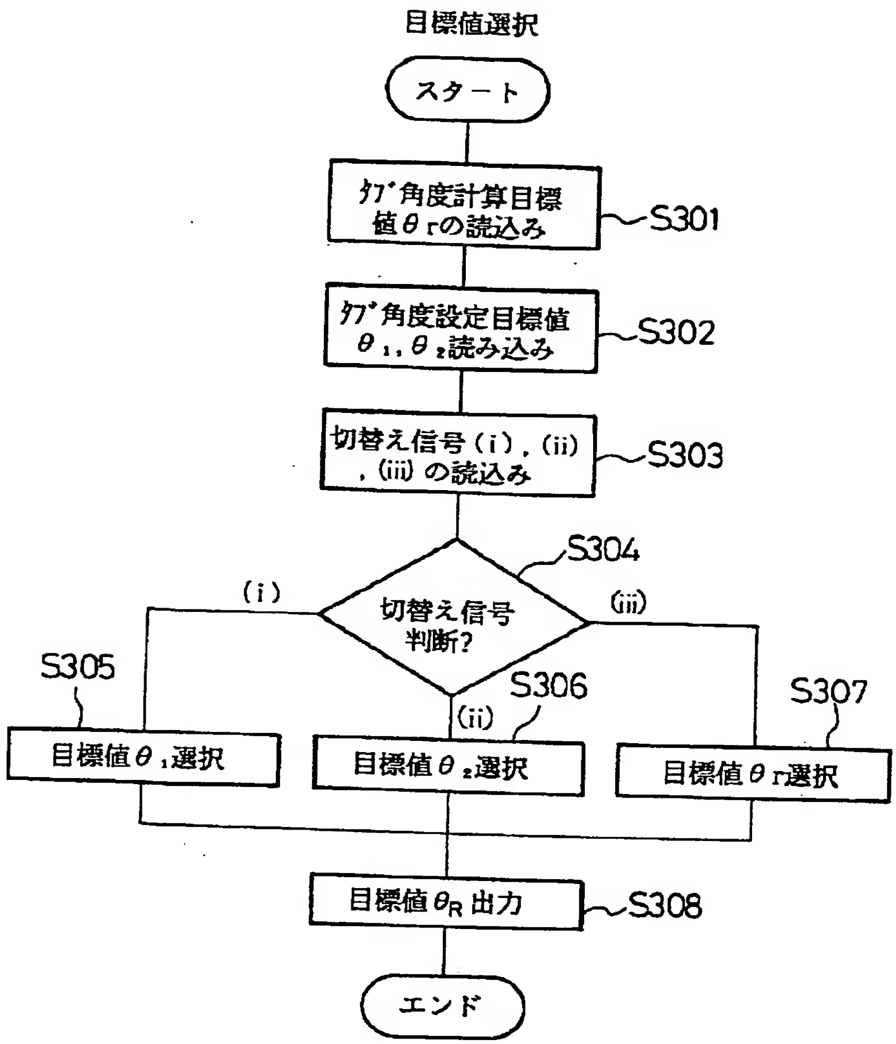
【図７】


ﾀﾌﾞ角度計算
スタート
検出ロール角φの読込み
S201
移動平均値φa計算
S202
決定目標値φoの読み込み
S203
ヒール角偏差計算
φe=φa-φo
S204
ﾀﾌﾞ角度目標値θr計算
S205
ﾀﾌﾞ角度θr出力
S206
エンド

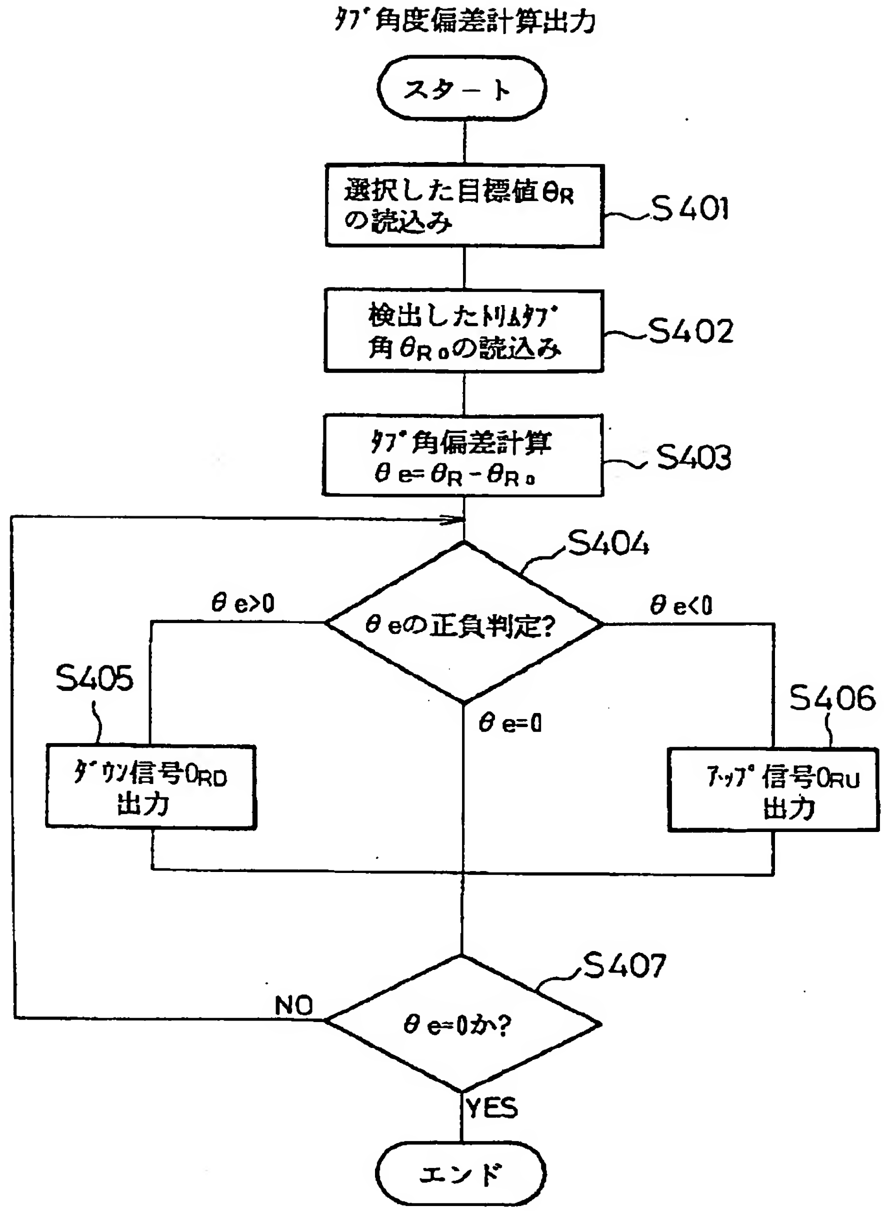
【図１０】


ﾌﾟﾚｰﾆﾝｸﾞ
(a)
ヒール角度
0
船速
(b)
トリム角度
0
船速

【図8】


目標値選択
スタート
ﾀﾌﾞ角度計算目標値θrの読込み
S301
ﾀﾌﾞ角度設定目標値θ1，θ2読み込み
S302
切替え信号（i），(ii)，(iii) の読込み
S303
S304
切替え信号判断?
(i)
(ii)
(iii)
S305
S306
S307
目標値θ1選択
目標値θ2選択
目標値θr選択
目標値θR 出力
S308
エンド

【図９】



フロントページの続き

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CLAIMS

[Claim(s)]
[Claim 1] Automatic attitude control equipment of a vessel characterized by providing the following The roll angle sensor which outputs a roll include-angle signal according to the roll include angle of a hull The driving means which changes the include angle of a trim tab according to the output signal which connects with the yaw angle sensor which outputs a yaw include-angle signal according to the yaw include angle of a hull, the rate sensor which outputs a speed signal according to vessel speed, the trim tab which controls the posture of a hull, the controller which outputs a signal according to the NAV conditions from said sensor, and this controller, and is sent from a controller
[Claim 2] Automatic attitude control equipment of a vessel characterized by providing the following The roll angle sensor which outputs a roll include-angle signal according to the roll include angle of a hull The driving means which changes the include angle of a trim tab according to the output signal which connects with the yaw angle sensor which outputs a yaw include-angle signal according to the yaw include angle of a hull, the rate sensor which outputs a speed signal according to vessel speed, the trim-tab angle sensor which outputs an include-angle signal according to the drive include angle of a trim tab, the trim tab which controls the posture of a hull, the controller which outputs a signal according to the NAV conditions from said sensor, and this controller, and is sent from a controller
[Claim 3] It is automatic attitude control equipment of a vessel which is equipped with the following and characterized by said controller controlling the include angle of said trim tab by said roll include-angle signal and said trim-tab include-angle signal according to a NAV condition while judging the NAV condition of a ship from said yaw include-angle signal and said speed signal. The trim tab which controls the posture of a hull The controller which outputs a signal according to NAV conditions The driving means which changes the include angle of a trim tab according to the output signal which connects with this controller and is sent from a controller The roll angle sensor which outputs a roll include-angle signal according to the roll include angle of a hull, the yaw include-angle signal sensor which outputs a yaw include-angle signal according to the yaw include angle of a hull, the rate sensor which outputs a speed signal according to vessel speed, and the trim-tab angle sensor which outputs an include-angle signal according to the drive include angle of a trim tab
[Claim 4] Automatic attitude control equipment of a vessel characterized by providing the following. The trim tab which controls the posture of a hull The controller which outputs a signal according to NAV conditions The driving means which changes the include angle of a trim tab according to the output signal which connects with this controller and is sent from a controller The roll angle sensor which outputs a roll include-angle signal according to the roll include angle of a hull, The yaw angle sensor which outputs a yaw include-angle signal according to the yaw include angle of a hull, It consists of a rate sensor which outputs a speed signal according to vessel speed, and a trim-tab angle sensor which outputs an include-angle signal according to the drive include angle of a trim tab. The rate-of-change count section which said controller considers said yaw include-angle signal as an input, and outputs a yaw angular rate signal, The velocity level judging section which considers a speed signal as an input and outputs a velocity level signal, The average processing section which has the control approach change section which considers said yaw angular rate signal and said velocity level signal as an input, judges a NAV condition, and outputs a control change signal, and equalizes said roll include-angle signal, and outputs a heel include-angle signal, The heel include-angle deflection count section which considers a heel include-angle signal and a heel include-angle desired value signal as an input, and outputs a heel include-angle deflection signal, The tab include-angle desired value count section which considers a heel include-angle deflection signal as an input, and calculates the desired value of a trim-tab include angle, The desired

value selection section which has the tab include-angle desired value setting section which has set up the target trim-tab include angle beforehand, chooses tab include-angle desired value with said control approach change signal further, and outputs tab include-angle desired value, The output section which considers as an input the tab include-angle deflection signal and tab include-angle deflection signal which consider tab include-angle desired value and a trim-tab include-angle signal as an input, and calculate tab include-angle deflection, and outputs a driving signal
[Claim 5] claim 1, claim 2, claim 3, or the automatic attitude control equipment of a vessel according to claim 4 -- it is -- said controller -- each of said sensor signal -- an input -- carry out -- NAV conditions -- respond -- heel include angle control and revolution tense -- a bow -- the automatic attitude control equipment of the vessel characterize by to output the desired value which chose control whenever [in a relief condition / angle of trim], and was determined in each control approach.
[Claim 6] It is automatic attitude control equipment of the vessel characterized by being automatic attitude control equipment of a vessel according to claim 5, and for said heel include-angle control judging a NAV condition with said yaw include-angle signal and said speed signal, and controlling the include angle of said trim tab by the heel include-angle signal and said trim-tab include-angle signal.
[Claim 7] Automatic attitude control equipment of the vessel characterized by controlling a trim tab to the desired value set up beforehand when it is automatic attitude control equipment of a vessel according to claim 5, a NAV condition is judged from said yaw include-angle signal and said speed signal and it is judged as the time of revolution.
[Claim 8] the automatic attitude control equipment of a vessel according to claim 5 -- it is -- said bow -- the automatic attitude control equipment of the vessel characterized by for control judging a NAV condition from said speed signal, and controlling a trim tab to the desired value set up beforehand whenever [in a relief condition / angle-of-trim].
[Claim 9] It is automatic attitude control equipment of the vessel characterized by being claim 1, claim 2, claim 3, claim 4, claim 5, claim 6, claim 7, and automatic attitude control equipment of a vessel according to claim 8, and for said roll include angle detecting the angular velocity of the roll direction of a hull with an oscillating gyroscope, and integrating with and computing said angular velocity.
[Claim 10] It is automatic attitude control equipment of the vessel characterized by being claim 1, claim 2, claim 3, claim 4, claim 5, claim 6, claim 7, and automatic attitude control equipment of a vessel according to claim 8, and for said roll include angle detecting the acceleration of the roll direction of a hull with an accelerometer, and computing the tilt angle of said hull based on said acceleration.
[Claim 11] It is automatic attitude control equipment of the vessel characterized by being claim 1, claim 2, claim 3, claim 4, claim 5, claim 6, claim 7, and automatic attitude control equipment of a vessel according to claim 8, and said roll include angle detecting the tilt angle of the roll direction of a hull with an inclinometer.
[Claim 12] It is claim 1, claim 2, claim 3, claim 4, claim 5, claim 6, claim 7, and automatic attitude control equipment of a vessel according to claim 8, and said yaw include angle detects the relative bearing of a hull with a magnetometric sensor, and is characterized by outputting this as a yaw include angle. Automatic attitude control equipment of a vessel
[Claim 13] Automatic attitude control equipment of the vessel which is automatic attitude control equipment of a vessel according to claim 5, has the device which controls said trim tab automatically, and the device driven with hand control, and is characterized by being switchable to arbitration in this automatic and hand control.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the automatic attitude control equipment of the vessel which controls the include angle of a trim tab automatically in order to stabilize the posture of vessels, such as a motorboat.
[0002]
[Description of the Prior Art] As automatic attitude control equipment of the conventional vessel, there are some which were shown, for example in JP,3-82697,A and JP,3-114996,A.
[0003] The thing of JP,3-82697,A is a configuration which similarly controls a trim-tab include angle according to the output of a sensor and a roll angle sensor whenever [torque-sensor / which detects the amount of operation /, and pitch angle / which detects the posture of a hull according to the output of the rate sensor which detects vessel speed].
[0004] In JP,3-114996,A, it has composition which similarly controls a trim-tab include angle according to the output of a sensor and a roll angle sensor whenever [pitch angle / which detects the posture of a hull].
[0005]
[Problem(s) to be Solved by the Invention] However, the thing given in JP,3-82697,A did not detect the posture of a hull itself, but determined the include angle of a trim tab uniquely that a bow will not come floating according to vessel speed at the time of abbreviation rectilinear propagation, and since it had become the configuration which controls the include angle of a trim tab so that the heel (heel angle) of a hull might be made to ease according to amounts of control at the time of the reliance rudder operation by the time of revolution, a flank wind, etc., it had caused the following problems.
[0006] ** A heel and rolling cannot be completely prevented at the time of abbreviation rectilinear propagation.
[0007] ** Since it becomes the factor which loses the travelling-figure balance of a ship, it is not effective to control a trim-tab include angle regardless of the posture of the hull before revolution steering and under revolution steering at the time of revolution.
[0008] Moreover, controlling a trim tab in the direction which reduces the inner inclination which is an effective posture for originally resisting a centrifugal force (lateral acceleration) at the time of revolution increases the lateral acceleration which crew feels, and it may give crew sense of incongruity.
[0009] Although a thing given in JP,3-114996,A, on the other hand, also has the composition which detects whenever [pitch-angle], and the roll include angle showing the posture of a ship itself, is the configuration which controls a trim-tab include angle, gives and carries out the comparison operation of whenever [target pitch-angle], and the target roll include angle further, and controls a trim-tab include angle and control of a roll include angle and whenever [pitch-angle] was always performing regardless of the NAV condition of a ship, there were the following problems.
[0010] ** Since yaw include-angle change or rudder angle change of a ship is not detected, revolution steering for course modification will not be able to be detected and it will be controlled in the direction which reduces an inner inclination too at the time of revolution.
[0011] ** Since the agitation angle is always controlled, the load of the actuators (a motor, oil hydraulic cylinder, etc.) which drive a trim tab becomes high.
[0012] Then, this invention aims at offer of the automatic attitude control equipment of the vessel which can double with the NAV condition of a ship and can perform efficient and highly precise attitude control.
[0013]

[Means for Solving the Problem] In order to solve the above-mentioned technical problem invention of claim 1 The roll angle sensor which outputs a roll include-angle signal according to the roll include angle of a hull, The yaw angle sensor which outputs a yaw include-angle signal according to the yaw include angle of a hull, The rate sensor which outputs a speed signal according to vessel speed, and the trim tab which controls the posture of a hull, the controller which outputs a signal according to the NAV conditions from said sensor, and the driving means which changes the include angle of a trim tab according to the output signal which connects with this controller and is sent from a controller -- since -- it is characterized by becoming.
[0014] The roll angle sensor to which invention of claim 2 outputs a roll include-angle signal according to the roll include angle of a hull, The yaw angle sensor which outputs a yaw include-angle signal according to the yaw include angle of a hull, The rate sensor which outputs a speed signal according to vessel speed, and the trim-tab angle sensor which outputs an include-angle signal according to the drive include angle of a trim tab, It connects with the trim tab which controls the posture of a hull, the controller which outputs a signal according to the NAV conditions from said sensor, and this controller, and is characterized by consisting of a driving means which changes the include angle of a trim tab according to the output signal sent from a controller.
[0015] The trim tab by which invention of claim 3 controls the posture of a hull, and the controller which outputs a signal according to NAV conditions, The driving means which changes the include angle of a trim tab according to the output signal which connects with this controller and is sent from a controller, The roll angle sensor which outputs a roll include-angle signal according to the roll include angle of a hull, The yaw include-angle signal sensor which outputs a yaw include-angle signal according to the yaw include angle of a hull, It consists of a rate sensor which outputs a speed signal according to vessel speed, and a trim-tab angle sensor which outputs an include-angle signal according to the drive include angle of a trim tab. Said controller is characterized by controlling the include angle of said trim tab by said roll include-angle signal and said trim-tab include-angle signal according to a NAV condition while it judges the NAV condition of a ship from said yaw include-angle signal and said speed signal.
[0016] The trim tab by which invention of claim 4 controls the posture of a hull, and the controller which outputs a signal according to NAV conditions, The driving means which changes the include angle of a trim tab according to the output signal which connects with this controller and is sent from a controller, The roll angle sensor which outputs a roll include-angle signal according to the roll include angle of a hull, The yaw angle sensor which outputs a yaw include-angle signal according to the yaw include angle of a hull, It consists of a rate sensor which outputs a speed signal according to vessel speed, and a trim-tab angle sensor which outputs an include-angle signal according to the drive include angle of a trim tab. The rate-of-change count section which said controller considers said yaw include-angle signal as an input, and outputs a yaw angular rate signal, The velocity level judging section which considers a speed signal as an input and outputs a velocity level signal, The average processing section which has the control approach change section which considers said yaw angular rate signal and said velocity level signal as an input, judges a NAV condition, and outputs a control change signal, and equalizes said roll include-angle signal, and outputs a heel include-angle signal, The heel include-angle deflection count section which considers a heel include-angle signal and a heel include-angle desired value signal as an input, and outputs a heel include-angle deflection signal, The tab include-angle desired value count section which considers a heel include-angle deflection signal as an input, and calculates the desired value of a trim-tab include angle, The desired value selection section which has the tab include-angle desired value setting section which has set up the target trim-tab include angle beforehand, chooses tab include-angle desired value with said control approach change signal further, and outputs tab include-angle desired value, It is characterized by having the output section which considers as an input the tab include-angle deflection signal and tab include-angle deflection signal which consider tab include-angle desired value and a trim-tab include-angle signal as an input, and calculate tab include-angle deflection, and outputs a driving signal.
[0017] invention of claim 5 -- claim 1, claim 2, claim 3, or the automatic attitude control equipment of a vessel according to claim 4 -- it be -- said controller -- said each sensor signal -- an input -- carry out -- NAV conditions -- respond -- heel include angle control and revolution tense -- a bow -- control be choose whenever [in a relief condition / angle of trim], and it be characterize by output the desired value determined in each control approach.
[0018] Invention of claim 6 is automatic attitude control equipment of a vessel according to claim 5, and said heel include-angle control judges a NAV condition with said yaw include-angle signal and said speed signal, and is characterized by controlling the include angle of said trim tab by the heel include-angle signal and said trim-tab include-angle signal.

[0019] It is characterized by invention of claim 7 controlling a trim tab to the desired value set up beforehand, when it is automatic attitude control equipment of a vessel according to claim 5, a NAV condition is judged from said yaw include-angle signal and said speed signal and it is judged as the time of revolution.
[0020] invention of claim 8 -- the automatic attitude control equipment of a vessel according to claim 5 -- it is -- said bow -- it is characterized by for control judging a NAV condition from said speed signal, and controlling a trim tab to the desired value set up beforehand whenever [in a relief condition / angle-of-trim].
[0021] Invention of claim 9 is claim 1, claim 2, claim 3, claim 4, claim 5, claim 6, claim 7, and automatic attitude control equipment of a vessel according to claim 8, and said roll include angle detects the angular velocity of the roll direction of a hull with an oscillating gyroscope, and is characterized by integrating with and computing said angular velocity.
[0022] Invention of claim 10 is claim 1, claim 2, claim 3, claim 4, claim 5, claim 6, claim 7, and automatic attitude control equipment of a vessel according to claim 8, and said roll include angle detects the acceleration of the roll direction of a hull with an accelerometer, and is characterized by computing the tilt angle of said hull based on said acceleration.
[0023] Invention of claim 11 is claim 1, claim 2, claim 3, claim 4, claim 5, claim 6, claim 7, and automatic attitude control equipment of a vessel according to claim 8, and said roll include angle is characterized by detecting the tilt angle of the roll direction of a hull with an inclinometer.
[0024] Invention of claim 12 is claim 1, claim 2, claim 3, claim 4, claim 5, claim 6, claim 7, and automatic attitude control equipment of a vessel according to claim 8, and said yaw include angle detects the relative bearing of a hull with a magnetometric sensor, and is characterized by outputting this as a yaw include angle.
[0025] Invention of claim 13 is automatic attitude control equipment of a vessel according to claim 5, has the device which controls said trim tab automatically, and the device driven with hand control, and is characterized by being switchable to arbitration in this automatic and hand control.
[0026]
[Function] According to invention of claim 1 of the above-mentioned means, based on the roll include angle of a hull, a yaw include angle, and vessel speed, a driving means can be controlled by the controller and the include angle of a trim tab can be changed.
[0027] According to invention of claim 2, based on the roll include angle of a hull, a yaw include angle, and the include angle of vessel speed and a trim tab, a controller can control a driving means, and the include angle of a trim tab can be changed.
[0028] According to invention of claim 3, from a yaw include-angle signal and a speed signal, the NAV condition of a ship can be judged and the include angle of a trim tab can be controlled by the roll include-angle signal and the trim-tab include-angle signal according to a NAV condition.
[0029] According to invention of claim 4, input a yaw angular rate and a velocity level and a NAV condition is judged. Heel include-angle deflection is calculated with the heel include-angle signal and heel include-angle desired value signal which enabled the change of the control approach based on the judgment of this NAV condition, and equalized the roll include-angle signal. The desired value of a trim-tab include angle is calculated by considering this heel include-angle deflection signal as an input. Moreover, a target trim-tab include angle is set up beforehand, tab include-angle desired value is further chosen with the control approach change signal, tab angle desired value is outputted, tab include-angle deflection can be calculated by the ability to input tab include-angle desired value and a trim-tab include-angle signal, and a driving signal can be outputted.
[0030] according to invention of claim 5 -- a NAV condition -- responding -- heel include-angle control and revolution tense -- a bow -- the trim-tab include-angle control in a relief condition can be chosen, and the desired value determined in each control approach can be outputted.
[0031] According to invention of claim 6, from a yaw include-angle signal and a speed signal, a NAV condition can be judged, the include angle of a trim tab can be controlled by the heel include-angle signal and the trim-tab include-angle signal, and heel include-angle control can be performed.
[0032] According to invention of claim 7, when a NAV condition is judged and it is judged as the time of revolution from a yaw include-angle signal and a speed signal, a trim tab can be set as the desired value set up beforehand.
[0033] According to invention of claim 8, a NAV condition can be judged with a speed signal and a trim tab can be controlled to the desired value set up beforehand.

[0034] According to invention of claim 9, a roll include angle can be computed by the ability for an oscillating gyroscope to detect the angular velocity of the roll direction of a hull, and integrate with angular velocity.
[0035] According to invention of claim 10, an accelerometer can detect the acceleration of the roll direction of a hull, the tilt angle of a hull can be computed based on this acceleration, and it can ask for a roll include angle.
[0036] According to invention of claim 11, an inclinometer can detect the tilt angle of the roll direction of a hull, and it can ask for a roll include angle.
[0037] According to invention of claim 12, a magnetometric sensor can detect the relative bearing of a hull and this can be outputted as a yaw include angle.
[0038] According to invention of claim 13, automatic and hand control can be changed to arbitration and a trim tab can be controlled.
[0039]
[Example] Hereafter, the example of this invention is explained.
[0040] Drawing 1 is the general drawing of a system configuration seen from the hull upper part.
[0041] 1 is a hull, 2 is a handle and he is trying for the turning effort of a handle 2 to rock a screw 5 right and left through a wire 3. Said screw 5 which can give turning effort with an engine 4 is connected to an engine 4. He changes the direction of a thrust and is trying to make it circle in a hull by rocking a screw 5 right and left by rotation of a handle 2.
[0042] The yaw angle sensor 11 which detects the deflection include angle to the longitudinal direction of a bow, the roll angle sensor 12 which detects the agitation angle of the longitudinal direction of a hull, and the rate sensor 15 which detects the rate of a hull are connected to a controller 10. In addition, a roll include angle can detect the angular velocity of the roll direction to a hull with an oscillating gyroscope, and can integrate with and compute said angular velocity. Moreover, it can ask by an accelerometer's detecting the acceleration of the roll direction of a hull and computing the tilt angle of a hull based on this acceleration. Furthermore, it can ask for a roll include angle by detecting the tilt angle of the roll direction of a hull with an inclinometer. A yaw include angle can detect the relative bearing of a hull with a magnetometric sensor, and can output this as a yaw include angle.
[0043] He is trying to input into a controller 10 the yaw include-angle signal omega detected by said yaw angle sensor 11, the roll include-angle signal phi detected by the roll angle sensor 12, and the speed signal upsilon detected by the rate sensor 15, respectively.
[0044] Moreover, the manually-operated switch (14R for right trim tabs, 14L for left trim tabs) for operating manually the transfer switch 13 and trim tabs 6R and 6L which switch whether the angle sensor (16R for right trim tabs, 16L for left trim tabs) which detects the include angle of trim tabs 6R and 6L, and trim tabs 6R and 6L are controlled automatically, or it operates manually is connected to a controller 10.
[0045] Furthermore, the controller 10 is connected with the dc-battery 9 through an electric power switch 17. When an electric power switch 17 is OFF, it has composition which actuation of a controller 10 suspends.
[0046] The controller 10 has connected the output to the driving means which changes the include angle of trim tabs 6R and 6L according to the signal outputted from a controller 10.
[0047] The driving means of the trim tabs 6R and 6L of this example is constituted as follows. An output signal is embraced from a controller 10, and hydraulic motors 8R and 8L are rotated normally and reversed. According to normal rotation of hydraulic motors 8R and 8L and reversal, Cylinders 7R and 7L perform flexible movement. Trim tabs 6R and 6L are made to move up and down by flexible movement of these cylinders 7R and 7L.
[0048] Next, drawing 2 explains the internal configuration of a controller 10.
[0049] A speed signal upsilon is first inputted into a controller 10 from said rate sensor 15, and this speed signal v is sent to the velocity level judging section 20.
[0050] The constant value v1 for judging a NAV condition and v2 (v1 and <v2) are beforehand set as the interior by this velocity level judging section 20. v1 the bow of a ** idling condition and a ship -- it is boundary value with a relief condition. v2 It is the boundary value of a ****** relief condition and a plane condition. This v1 and v2 A value can be set as any value according to the NAV conditions of a ship, or the property of a hull.
[0051] In addition, a property as generally shown in drawing 3 has the relation between vessel speed and an angle of trim.
[0052] In said velocity level judging section 20, the velocity level of a ship is classified into the following three kinds by the following judgment type.

[0053]
(1) v<v1 (idling condition)
(2) v1 <=v<=v2 (bow relief condition)
(3) v2 <v1 (plane condition) -- At the time of the conditions of the 1st formula (1) (1) signal is outputted to the control approach change section 22.
[0054] At the time of the conditions of (2) (2) signals are outputted to the control approach change section 22.
[0055] At the time of the conditions of (3) (3) signals are outputted to the control approach change section 22.
[0056] Moreover, if the yaw include-angle signal upsilon is inputted into a controller 10 from said yaw angle sensor 11, this yaw include-angle signal omega will be sent to the rate-of-change count section 21.
[0057] Yaw angular rate which is yaw include-angle change for every unit time amount according to the yaw include-angle signal omega inputted in this rate-of-change count section 21 d omega/dt It calculates. And calculated yaw angular rate d omega/dt The rate-of-change count section 21 carries out a comparison operation to constant value domegao/dt set up beforehand, and chooses an output signal. Domegao/dt is boundary value the NAV condition of a ship judges the time of current, rectilinear propagation, and revolution to be. this -- The value of domegao/dt can be set as any value according to the NAV conditions of a ship, or the property of a hull. (**) d omega/dt < Domegao/dt (at the time of rectilinear propagation)
(**) d omega/dt >= Domegao/dt (at the time of revolution) -- 2nd formula (b) At the time of conditions (b) A signal is outputted to the control approach change section 22.
[0058] (b) At the time of ****** (b) A signal is outputted to the control approach change section 22.
[0059] Instruction signal when the velocity level signal from the aforementioned velocity level judging section 20 and the rate-of-change signal from the aforementioned rate-of-change count section 21 are inputted into the control approach change section 22, as shown in drawing 4 in the control approach change section 22 with the combination of the velocity level signal and rate-of-change signal which were inputted (i) - (iii) It determines and outputs to the desired value selection sections 30 and 31.
[0060] Change instruction signal (i) - (iii) (i) Instruction signal changed into the condition of having raised the trim tab to the top
(ii) Instruction signal which changes a trim tab into the condition of having lowered to the bottom
(iii) Instruction signal which performs heel include-angle control
It means.
[0061] Namely, it is a change instruction signal (i) regardless of a judgment at the time of rectilinear propagation [in / when the velocity level of the ship in the 1st formula is judged to be an idling condition / the 2nd formula], and revolution. That is, a trim tab is controlled in the condition of having raised to the top.
[0062] moreover, the velocity level in the 1st formula -- a bow -- when it judges with a relief condition (run state before plane shift), the change instruction signal (ii) 6R and 6L, i.e., trim tabs, is controlled in the condition of having lowered most, regardless of a judgment at the time of the rectilinear propagation in the 2nd formula, and revolution.
[0063] This has the effective control which was mentioned above and which lowers a bow until it shifts to a plane condition like, and rolling control in this condition and heel include-angle control are because there is little effectiveness.
[0064] furthermore, the case where it is judged with the time of rectilinear propagation by the 2nd formula when the velocity level in the 1st formula is judged to be a plane condition -- change instruction signal (iii) namely, the case where heel include-angle control is judged to be the time of operation and revolution -- change instruction signal (i) That is, it controls in the condition of having raised trim tabs 6R and 6L most.
[0065] Thereby, at the time of rectilinear propagation, only a plane condition carries out heel include-angle control, and it controls not to check the heel which is the property which a ship originally has at the time of revolution.
[0066] On the other hand, the roll include-angle signal phi is inputted into a controller 10 from the roll angle sensor 12, and this roll include-angle signal phi is sent to the average processing section 23.
[0067] In this average processing section 23, from the inputted roll include-angle signal phi, the 3rd following formula is calculated and a moving average deviation is calculated. This moving average deviation is set to heel include-angle phia.
[0068]
[Equation 1]

$$\phi ak = \frac{1}{n'} \sum_{i=k-n'}^{k} \phi i$$ …第3式

ここでiは（k－n'），（k－n'＋1），（k－n'＋2），……，k

{K－（k－n'＋n'）}

As for roll include-angle phiak in i time, phii shows the heel include angle in k time.
[0069] phiak, i.e., phii, is n'. It is the average of the value which ****(ed).
[0070] phi makes a dextroversion oblique position forward to a travelling direction.
[0071] Heel include-angle phia calculated by the 3rd formula is made into an output signal, and it outputs to the heel-angle deflection count section 25.
[0072] Target heel include-angle signal phio which shows the target heel include angle beforehand set to this heel-angle deflection count section 25 in the desired value decision section 24 in addition to this It has inputted.
[0073] In this heel-angle deflection count section 25, the 4th following formula is calculated and it asks for heel include-angle deflection signal phie.
[0074]
phie=phia-phio -- A hull makes the clockwise direction forward to a travelling direction here the 4th formula.
[0075] This heel include-angle deflection signal phie is outputted to the tab include-angle desired value count sections 26 and 27.
[0076] In the tab include-angle desired value count section 26, after judging the positive/negative of phie based on inputted heel include-angle deflection signal phie, the PID operation of the 5th formula is performed and it asks for tab include-angle desired value thetar of a right trim tab.
[0077]
[Equation 2]
$\phi e \geqq 0$なら

$$\theta r = K_p \phi_e + T_D \frac{d}{dt} \phi_e + \frac{1}{T_I} \int \phi_e \, dt$$ …第5式

$\phi e < 0$なら

$\theta r = 0$

ここで、K_p，T_D，T_Iは定数である。

After judging the positive/negative of phie based on inputted heel include-angle deflection signal phie in the tab angle desired value count section 27, the following PID operation of the 6th formula is performed and it is tab angle desired value thetal of left trim-tab 6L. It asks.
[0078]
[Equation 3]

$\phi e \geq 0$なら

$\theta \ell = 0$

$\phi e < 0$なら

$$\theta \ell = -\left(K_p \phi_e + T_D \frac{d}{dt} \phi_e + \frac{1}{T_I} \int \phi_e \, dt\right) \qquad \cdots 第6式$$

ここで、K_p, T_D, T_I は定数である。

In addition, the 1st term Kpphie of the 6th formula gives the tab include angle proportional to heel include-angle deflection signal phie to the 5th formula list. That is, the tab include angle of the right or the left is enlarged, so that the absolute value of heel include-angle deflection signal phie is large.
[0079] This 2nd term does not give the tab include angle proportional to the differential value of heel include-angle deflection signal phie, if this differential value is not large, it gives that much big tab include angle, and it is raising the responsibility which decreases the heel include angle of a hull.
[0080] This 3rd term gives the tab include angle proportional to the integral value of heel include-angle deflection signal phie, and this has given the tab include angle which negates the heel (heel include angle) of the steady hull produced according to the property and external force of a hull.
[0081] Right tab angle desired value thetar called for here is outputted to the desired value selection section 30. Moreover, left tab desired value thetal It is outputted to the desired value selection section 31.
[0082] Explanation to the output signal decision of a right trim tab is given to below. The flow to the output-signal decision of a left trim tab is completely the same as a right trim tab, and explanation is omitted.
[0083] Change instruction signal outputted to the target selection section 30 from the above mentioned control approach change section 22 (i) - (iii) The right tab angle desired value setting section 28 which set up the target tab angle beforehand although tab include-angle desired value thetar outputted from the right tab include-angle desired value count section 26 was inputted to the target set point theta 1, and theta 2 It has inputted. Target set point theta 1 It is the set point in the condition of having raised trim-tab 6R most. Target set point theta 2 It is the set point in the condition of having lowered trim-tab 6R most.
[0084] At the desired value selection section 30, it is a change instruction signal (i). - (iii) It corresponds and is desired value thetar of a right tab include angle, theta 1, and theta 2. It chooses. The selection correspondence is as follows.
[0085]
change instruction signal Tab angle desired value (i) The time theta 1 Selection (ii) The time theta 2 Selection (iii) The time thetar selection -- the right tab include-angle desired value chosen by this -- thetaR =theta1 -, theta 2, or thetar ** -- it carries out.
[0086] Right tab include-angle desired value thetaR chosen in the desired value selection section 30 It is outputted to the right tab angle deflection count section 32.
[0087] Tab angle desired value thetaR inputted into the right tab angle deflection count section 32 Include-angle signal thetaRo detected by trim-tab angle sensor 16R is also inputted into others.
[0088] The 7th following formula is calculated in the right tab angle deflection count section 32, and it is deflection include-angle thetae. It asks. thetae =thetaR-thetaRo -- It is thetae to the 7th formula pan. Positive/negative distinction is performed and it is deviation-angle thetae. The signal which rises and brings down trim-tab 6R so that it may become zero is determined as follows.
[0089]

thetae When it is forward Down signal (0RD)
thetae When it is negative Rise signal (0RU)
This rise down signal is outputted to the right output section 34.
[0090] In the right output section 34, the change signal and the manual ringing from right manual switch 14R which rise down signal 0RU or 0RD determined in the right tab angle deflection count section 32 is considered as an input, and also consider an on-off signal as an output from a changeover switch 13 are inputted.
[0091] That is, he is trying to change automatic and manual trim-tab control in the right output section 34 with the change signal inputted from a changeover switch 13.
[0092] When a changeover switch 13 is ON, it considers as automatic, and it outputs to hydraulic-motor 8R by making into an output signal rise down signal 0RD or 0RU determined above.
[0093] When a changeover switch 13 is OFF, it considers as hand control, and the rise down signal determined by actuation of right manual switch 14R is outputted to hydraulic-motor 8R as an output of the right output section 34.
[0094] Although control of right trim-tab 6R was explained above, the same is said of the left trim-tab 6L.
[0095] Here, there are little increase of water pressure which starts a ship's bottom since the draft of the stern is deep until it goes into a plane condition in a planing boat, and rolling. Actuation which lowers a bow when right and left take down a trim tab conventionally, since the shift to a plane becomes slow while a bow goes up by subduction of the stern on the other hand in the meantime and a front field of view gets worse is performed, and control of the example of this invention also applies to this.
[0096] On the other hand, in a plane condition, a draft becomes shallow and agitation of a ship becomes active. When rolling is compared with pitching in this condition, the pitching period is usually longer and the direction of rolling is felt sensitively. Moreover, although the effectiveness of lowering the bow which went up too much on the structure, as for the attitude control using a trim tab is expectable, there is no effectiveness of raising the bow which fell too much. Therefore, the attitude control in a plane condition has more effective control of rolling.
[0097] However, since a great quantity of loads will be given to a control actuator, always controlling all rolling does not tend to press down the agitation angle (rolling) of a hull itself, and it controls the average attitude angle (this is called heel angle) by the example of this invention.
[0098] Moreover, about the invalid nature of the rolling control at the time of revolution, although it is as above-mentioned, it uses that the level of the yaw angular rate in each differs at the time of rectilinear propagation and revolution for detection of a revolution condition. That is, if level with a yaw angular rate is exceeded, it can be judged as revolution.
[0099] Next, the control action of the above-mentioned controller 10 is explained based on the flow chart of drawing 9 from drawing 5 . In addition, also in this explanation, it carries out about control of right trim-tab 6R, and control of left trim-tab 6L is omitted.
[0100] First, overall control is performed like drawing 5 . That is, the change of the control approach is performed in step S1. The change of this control approach is said instruction signal (i). An instruction signal (ii) and instruction signal (iii) It is a change.
[0101] Tab include-angle count is performed at step S2. Tab include-angle count is performed based on detection of said roll angle sensor 12 (drawing 1).
[0102] Desired value selection is performed at step S3. Desired value selection embraces a NAV condition and is tab include-angle thetar, theta 1, and theta 2. It chooses.
[0103] In step S4, tab include-angle deflection count and an output are performed. Tab include-angle deflection count is selected desired value thetaR. It is calculated based on the trim-tab include angle detected by trim-tab angle sensor 16R (drawing 1). An output outputs the signal of a rise or a down to hydraulic-motor 8R so that deflection may be set to 0.
[0104] Next, the detail of step S1 - S4 is explained.
[0105] The change of the control approach of said step S1 is performed by the routine of drawing 6 . At step S101, reading of the rate v detected by the rate sensor 15 (drawing 1) is performed first.
[0106] The judgment of a velocity level is performed at step S102. It is (1), as this judgment was performed in the velocity level judging section 20 (drawing 1) and being described above. $v<v1$ (2) $v1 <= v <= v2$ (3) It is carried out about $v2 < v$ and is $v<v1$. A case is (1) at step S103. Selection of a signal is performed.
[0107] $v1 <= v <= v2$ A case is (2) at step S104. Selection of a signal is performed.

[0108] v2 In <v, set to step S105 and it is (3). Selection of a signal is performed.
[0109] Subsequently, reading of the yaw include angle omega detected by the yaw angle sensor 11 (drawing 1) in step S106 is performed.
[0110] A judgment of a NAV condition is made at step S107. This decision is performed in the rate-of-change count section 21 (drawing 1), and as described above, it carries out about (b) d omega/dt<d omega0 / dt (b) d omega/dt>=d omega 0 / dt.
[0111] In d omega/dt<d omega 0 / dt, selection of a (b) signal is performed in step S108.
[0112] In d omega/dt>=d omega 0 / dt, selection of a (b) signal is performed at step S109. If these signal selections are performed, based on these signals, a judgment of a rate and a NAV condition will be made in step S110. This judgment is made like said drawing 4 in the control approach change section 22.
[0113] Namely, (1) And (**) and (1) And (**) and (3) It reaches, in (**), it sets to step S111, and is (i). Selection of a signal is performed.
[0114] (2) And (**) and (2) And in (**), selection of the (ii) signal is performed in step S112.
[0115] (3) And when it is (**), set to step S113 (iii). Selection of a signal is performed.
[0116] These (i) A signal and (ii) signal (iii), The change of the control approach can be judged with a signal. therefore, the step S114 -- setting -- (i) or (ii) -- or (iii) it was chosen -- it changes and a signal is outputted.
[0117] Next, tab include-angle count of step S2 of said drawing 5 is performed by the routine of drawing 7 . In step S201, reading of detection roll angle phi is performed first. This reading is based on detection of said roll angle sensor 12 (drawing 1).
[0118] Subsequently, count of moving average deviation phia is performed in step S202. This average processing is performed in the average processing section 23 (drawing 1). Moving average deviation phia is outputted as a heel include angle, as described above.
[0119] It sets to step S203 and is decision target ground phio. Read in is performed. This decision target ground phio It is based on the value beforehand determined in said desired value decision section 24 (drawing 1).
[0120] Heel include-angle deflection count is performed at step S204. This heel include-angle deflection count is performed in the heel include-angle count section 25 (drawing 1), and phie =phia-phio is performed.
[0121] At step S205, it is tab include-angle desired value thetar. Count is performed. This count is performed in the right tab include-angle desired value count section 26 (drawing 1), as described above.
[0122] Next, it sets to step S206 and is tab include-angle thetar. An output is performed. This output is performed from the right tab include-angle desired value count section 26 to the desired value selection section 30.
[0123] Desired value selection of step S3 of said drawing 5 is performed based on the routine of drawing 8 . This routine is performed by the desired value selection section 30 (drawing 1).
[0124] It is tab include-angle count desired value thetar at step S301 first. Read in is performed. This desired value thetar It is based on the output from said desired value count section 26 (drawing 1).
[0125] At step S302, it is the tab include-angle setting desired value theta 1 and theta 2. Read in is performed. This desired value theta 1 and theta 2 It is based on the output from the right tab include-angle desired value setting section 28 (drawing 1).
[0126] It changes at step S303 and is a signal (i). (ii) (iii), Read in is performed. This read in is based on the output from said control approach change section 22.
[0127] At step S304, it changes and decision of a signal is performed. (i) It sets to step S305 and a case is desired value theta 1. Selection is performed. In (ii), it sets to step S306 and is desired value theta 2. Selection is performed. (iii) It sets to step S307 and a case is desired value thetar. Selection is performed. The these-chosen desired value theta 1, theta 2, and thetar Either is desired value thetaR. It carries out and is outputted in step S308. This output is performed from said desired value selection section 30 to the right tab include-angle deflection count section 32.
[0128] The tab include-angle deflection count output of step S4 of said drawing 5 is performed by the routine of drawing 9 . This routine is performed by said right tab include-angle deflection count section 32 and the right output section 34.
[0129] The desired value theta 1 first chosen in step S401, theta 2, and thetar Read in is performed. This read in is based on the output from the desired value selection section 30 (drawing 1).
[0130] At step S402, read in of detected trim-tab angle thetaRO is performed. This read in is based on the output from said trim-tab angle sensor 16R (drawing 1).

[0131] Tab angle deflection count is performed at step S403. This count performs thetae =thetaR-thetaRO.
[0132] Subsequently, it sets to step 404 and is thetae. A positive/negative judging is performed. thetae When it is forward, the output of the down signal ORD is performed in step S405. thetae When it is negative, the rise signal ORU is outputted in step S406. Said hydraulic-motor 8R drives and a trim-tab angle is controlled by this output at a down or rise side.
[0133] And decision of being thetae =0 is performed in step S407, and control will be ended if set to 0.
[0134] Thus, according to the NAV condition of a ship, trim tabs 6R and 6L can be controlled, and an efficient and highly precise posture system can be performed automatically. Moreover, the load of hydraulic motors 8L and 8R can be made into min, and endurance and dependability can be improved.
[0135] An example of the effectiveness by the above-mentioned example of this invention is shown in drawing 10 .
[0136] Drawing 10 (a) The heel include-angle depressor effect in every rate of a ship in the condition of having received the flank wind at the time of rectilinear propagation is shown.
[0137] In control according [the continuous line in drawing] to this invention example, in not controlling, a broken line shows the case where a two-dot chain line performs rolling control over the whole region, respectively.
[0138] It turns out to disturbance, such as a flank wind, that this invention example has very effective heel include-angle depressor effect so that clearly from these.
[0139] Moreover, since it is small, not in extent as which human being senses displeasure but in this field, the control effectiveness is known by that it is few, as the inclination in the field in front of non-controlled heel include-angle play NINGU was described above.
[0140] Drawing 10 (b) The trim depressor effect by this invention is shown similarly. In control according [the continuous line in drawing] to this invention, in not controlling, a broken line shows the case where a two-dot chain line performs pitching control over the whole region, respectively.
[0141] the bow according to the trim inhibitory control before play NINGU by this invention example so that clearly from these -- it turns out well the relief prevention effectiveness is not only acquired, but that trim depressor effect continues after play NINGU which is trim control sheep regulatory region.
[0142] Moreover, even if it performs trim inhibitory control in a low-speed area and the maximum high-speed region, effectiveness is well known by that it is small.
[0143] As mentioned above, although the configuration of the above-mentioned example, control logic, an operation, and effectiveness were explained, this invention is not limited to the configuration and control logic of the above-mentioned example.
[0144] For example, it is a correction term for raising control precision about each 2nd term and each 3rd term in the 5th formula and the 6th formula, and it is also possible to omit one of these or both sides.
[0145] Moreover, it sets in the tab angle deflection count sections 32 and 33, and is deflection include-angle thetae by the 7th formula. Although the rise down signal of a trim tab is outputted and driven in the output sections 34 and 35 after asking, it is also possible to drive a trim tab with the tab angle desired value itself chosen in the desired value selection sections 30 and 31.
[0146] In this case, the tab angle deflection count sections 32 and 33 and the trim-tab angle sensors 16R and 16L become omissible.
[0147] Moreover, in this configuration, a comparison operation with the roll angle after control is performed, and it cannot be overemphasized that feedback of the deflection by study etc. is possible.
[0148] It cannot be overemphasized that you may be the object which will not be limited to the object of a proper if said control is possible, and has two or more functions by one also about each sensor in an example.
[0149]
[Effect of the Invention] As mentioned above, according to invention of claim 1, control of a trim tab can be automatically controlled according to the roll include angle of a hull, a yaw include angle, and vessel speed, and highly precise attitude control can be automatically performed so that clearly.
[0150] According to invention of claim 2, control of a trim tab can be automatically controlled according to a roll include angle, a yaw include angle, and vessel speed and the detected trim-tab include angle, and highly precise attitude control can be performed automatically.
[0151] According to invention of claim 3, from a yaw include-angle signal and a speed signal, the NAV condition of a ship can be judged and the include angle of a trim tab can be controlled by this. Therefore, it can double with the NAV

condition of a ship and efficient and highly precise attitude control can be performed automatically.
[0152] According to invention of claim 4, a NAV condition can be judged based on a yaw angular rate and a velocity level judging, and the control approach can be changed. And tab include-angle desired value can be chosen with the change signal of the control approach, and a driving signal can be outputted. Therefore, highly precise attitude control can be performed automatically.
[0153] the heel include-angle control chosen according to NAV conditions in invention of claim 5, and revolution tense -- a bow -- the desired value determined in control whenever [in a relief condition / angle-of-trim] is outputted, and control according to NAV conditions can be performed accurately.
[0154] In invention of claim 6, from a yaw include-angle signal and a speed signal, a NAV condition can be judged, the include angle of a trim tab can be controlled with a heel include-angle signal and a trim-tab include-angle signal, and more accurate control can be performed.
[0155] When it is judged as the time of revolution according to invention of claim 7, a trim tab can be controlled to the desired value set up beforehand, and control at the time of revolution can be performed more accurately.
[0156] according to invention of claim 8 -- a bow -- it is [whenever / angle-of-trim / in a relief condition] accurately controllable.
[0157] A roll include angle can be computed by the ability for an oscillating gyroscope to detect the angular velocity of the roll direction of a hull according to invention of claim 9, and integrate with angular velocity, and exact control can be performed.
[0158] In invention of claim 10, an accelerometer detects the acceleration of the roll direction of a hull, and the tilt angle of a hull can be computed based on this acceleration, it can consider as a roll include angle, and exact control can be performed.
[0159] In invention of claim 11, an inclinometer can detect the tilt angle of the roll direction of a hull, it can consider as a roll include angle, and exact control can be performed.
[0160] In invention of claim 12, a magnetometric sensor detects the relative bearing of a hull, this is outputted as a yaw include angle, and exact control can be performed.
[0161] It is possible to correspond, also when control of a trim tab can be changed to automatic and hand control at arbitration, and can be performed in invention of claim 13 and automatic control breaks down.

[Translation done.]

TECHNICAL FIELD

[Industrial Application] This invention relates to the automatic attitude control equipment of the vessel which controls the include angle of a trim tab automatically in order to stabilize the posture of vessels, such as a motorboat.

[Translation done.]

PRIOR ART

[Description of the Prior Art] As automatic attitude control equipment of the conventional vessel, there are some which were shown, for example in JP,3-82697,A and JP,3-114996,A.
[0003] The thing of JP,3-82697,A is a configuration which similarly controls a trim-tab include angle according to the output of a sensor and a roll angle sensor whenever [torque-sensor / which detects the amount of operation /, and pitch angle / which detects the posture of a hull according to the output of the rate sensor which detects vessel speed].
[0004] In JP,3-114996,A, it has composition which similarly controls a trim-tab include angle according to the output of a sensor and a roll angle sensor whenever [pitch angle / which detects the posture of a hull].

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] As mentioned above, according to invention of claim 1, control of a trim tab can be automatically controlled according to the roll include angle of a hull, a yaw include angle, and vessel speed, and highly precise attitude control can be automatically performed so that clearly.
[0150] According to invention of claim 2, control of a trim tab can be automatically controlled according to a roll include angle, a yaw include angle, and vessel speed and the detected trim-tab include angle, and highly precise attitude control can be performed automatically.
[0151] According to invention of claim 3, from a yaw include-angle signal and a speed signal, the NAV condition of a ship can be judged and the include angle of a trim tab can be controlled by this. Therefore, it can double with the NAV condition of a ship and efficient and highly precise attitude control can be performed automatically.
[0152] According to invention of claim 4, a NAV condition can be judged based on a yaw angular rate and a velocity level judging, and the control approach can be changed. And tab include-angle desired value can be chosen with the change signal of the control approach, and a driving signal can be outputted. Therefore, highly precise attitude control can be performed automatically.
[0153] the heel include-angle control chosen according to NAV conditions in invention of claim 5, and revolution tense -- a bow -- the desired value determined in control whenever [in a relief condition / angle-of-trim] is outputted, and control according to NAV conditions can be performed accurately.
[0154] In invention of claim 6, from a yaw include-angle signal and a speed signal, a NAV condition can be judged, the include angle of a trim tab can be controlled with a heel include-angle signal and a trim-tab include-angle signal, and more accurate control can be performed.
[0155] When it is judged as the time of revolution according to invention of claim 7, a trim tab can be controlled to the desired value set up beforehand, and control at the time of revolution can be performed more accurately.
[0156] according to invention of claim 8 -- a bow -- it is [whenever / angle-of-trim / in a relief condition] accurately controllable.
[0157] A roll include angle can be computed by the ability for an oscillating gyroscope to detect the angular velocity of the roll direction of a hull according to invention of claim 9, and integrate with angular velocity, and exact control can be performed.
[0158] In invention of claim 10, an accelerometer detects the acceleration of the roll direction of a hull, and the tilt angle of a hull can be computed based on this acceleration, it can consider as a roll include angle, and exact control can be performed.
[0159] In invention of claim 11, an inclinometer can detect the tilt angle of the roll direction of a hull, it can consider as a roll include angle, and exact control can be performed.
[0160] In invention of claim 12, a magnetometric sensor detects the relative bearing of a hull, this is outputted as a yaw include angle, and exact control can be performed.
[0161] It is possible to correspond, also when control of a trim tab can be changed to automatic and hand control at arbitration, and can be performed in invention of claim 13 and automatic control breaks down.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, the thing given in JP,3-82697,A did not detect the posture of a hull itself, but determined the include angle of a trim tab uniquely that a bow will not come floating according to vessel speed at the time of abbreviation rectilinear propagation, and since it had become the configuration which controls the include angle of a trim tab so that the heel (heel angle) of a hull might be made to ease according to amounts of control at the time of the reliance rudder operation by the time of revolution, a flank wind, etc., it had caused the following problems.
[0006] ** A heel and rolling cannot be completely prevented at the time of abbreviation rectilinear propagation.
[0007] ** Since it becomes the factor which loses the travelling-figure balance of a ship, it is not effective to control a trim-tab include angle regardless of the posture of the hull before revolution steering and under revolution steering at the time of revolution.
[0008] Moreover, controlling a trim tab in the direction which reduces the inner inclination which is an effective posture for originally resisting a centrifugal force (lateral acceleration) at the time of revolution increases the lateral acceleration which crew feels, and it may give crew sense of incongruity.
[0009] Although a thing given in JP,3-114996,A, on the other hand, also has the composition which detects whenever [pitch-angle], and the roll include angle showing the posture of a ship itself, is the configuration which controls a trim-tab include angle, gives and carries out the comparison operation of whenever [target pitch-angle], and the target roll include angle further, and controls a trim-tab include angle and control of a roll include angle and whenever [pitch-angle] was always performing regardless of the NAV condition of a ship, there were the following problems.
[0010] ** Since yaw include-angle change or rudder angle change of a ship is not detected, revolution steering for course modification will not be able to be detected and it will be controlled in the direction which reduces an inner inclination too at the time of revolution.
[0011] ** Since the agitation angle is always controlled, the load of the actuators (a motor, oil hydraulic cylinder, etc.) which drive a trim tab becomes high.
[0012] Then, this invention aims at offer of the automatic attitude control equipment of the vessel which can double with the NAV condition of a ship and can perform efficient and highly precise attitude control.

[Translation done.]

MEANS

[Means for Solving the Problem] In order to solve the above-mentioned technical problem invention of claim 1 The roll angle sensor which outputs a roll include-angle signal according to the roll include angle of a hull, The yaw angle sensor which outputs a yaw include-angle signal according to the yaw include angle of a hull, The rate sensor which outputs a speed signal according to vessel speed, and the trim tab which controls the posture of a hull, the controller which outputs a signal according to the NAV conditions from said sensor, and the driving means which changes the include angle of a trim tab according to the output signal which connects with this controller and is sent from a controller -- since -- it is characterized by becoming.
[0014] The roll angle sensor to which invention of claim 2 outputs a roll include-angle signal according to the roll include angle of a hull, The yaw angle sensor which outputs a yaw include-angle signal according to the yaw include angle of a hull, The rate sensor which outputs a speed signal according to vessel speed, and the trim-tab angle sensor which outputs an include-angle signal according to the drive include angle of a trim tab, It connects with the trim tab which controls the posture of a hull, the controller which outputs a signal according to the NAV conditions from said sensor, and this controller, and is characterized by consisting of a driving means which changes the include angle of a trim tab according to the output signal sent from a controller.
[0015] The trim tab by which invention of claim 3 controls the posture of a hull, and the controller which outputs a signal according to NAV conditions, The driving means which changes the include angle of a trim tab according to the output signal which connects with this controller and is sent from a controller, The roll angle sensor which outputs a roll include-angle signal according to the roll include angle of a hull, The yaw include-angle signal sensor which outputs a yaw include-angle signal according to the yaw include angle of a hull, It consists of a rate sensor which outputs a speed signal according to vessel speed, and a trim-tab angle sensor which outputs an include-angle signal according to the drive include angle of a trim tab. Said controller is characterized by controlling the include angle of said trim tab by said roll include-angle signal and said trim-tab include-angle signal according to a NAV condition while it judges the NAV condition of a ship from said yaw include-angle signal and said speed signal.
[0016] The trim tab by which invention of claim 4 controls the posture of a hull, and the controller which outputs a signal according to NAV conditions, The driving means which changes the include angle of a trim tab according to the output signal which connects with this controller and is sent from a controller, The roll angle sensor which outputs a roll include-angle signal according to the roll include angle of a hull, The yaw angle sensor which outputs a yaw include-angle signal according to the yaw include angle of a hull, It consists of a rate sensor which outputs a speed signal according to vessel speed, and a trim-tab angle sensor which outputs an include-angle signal according to the drive include angle of a trim tab. The rate-of-change count section which said controller considers said yaw include-angle signal as an input, and outputs a yaw angular rate signal, The velocity level judging section which considers a speed signal as an input and outputs a velocity level signal, The average processing section which has the control approach change section which considers said yaw angular rate signal and said velocity level signal as an input, judges a NAV condition, and outputs a control change signal, and equalizes said roll include-angle signal, and outputs a heel include-angle signal, The heel include-angle deflection count section which considers a heel include-angle signal and a heel include-angle desired value signal as an input, and outputs a heel include-angle deflection signal, The tab include-angle desired value count section which considers a heel include-angle deflection signal as an input, and calculates the desired value of a trim-tab include angle, The desired value selection section which has the tab include-angle desired value setting section which has set up the target trim-tab include angle beforehand, chooses tab include-angle desired

value with said control approach change signal further, and outputs tab include-angle desired value, It is characterized by having the output section which considers as an input the tab include-angle deflection signal and tab include-angle deflection signal which consider tab include-angle desired value and a trim-tab include-angle signal as an input, and calculate tab include-angle deflection, and outputs a driving signal.
[0017] invention of claim 5 -- claim 1, claim 2, claim 3, or the automatic attitude control equipment of a vessel according to claim 4 -- it be -- said controller -- said each sensor signal -- an input -- carry out -- NAV conditions -- respond -- heel include angle control and revolution tense -- a bow -- control be choose whenever [in a relief condition / angle of trim], and it be characterize by output the desired value determined in each control approach.
[0018] Invention of claim 6 is automatic attitude control equipment of a vessel according to claim 5, and said heel include-angle control judges a NAV condition with said yaw include-angle signal and said speed signal, and is characterized by controlling the include angle of said trim tab by the heel include-angle signal and said trim-tab include-angle signal.
[0019] It is characterized by invention of claim 7 controlling a trim tab to the desired value set up beforehand, when it is automatic attitude control equipment of a vessel according to claim 5, a NAV condition is judged from said yaw include-angle signal and said speed signal and it is judged as the time of revolution.
[0020] invention of claim 8 -- the automatic attitude control equipment of a vessel according to claim 5 -- it is -- said bow -- it is characterized by for control judging a NAV condition from said speed signal, and controlling a trim tab to the desired value set up beforehand whenever [in a relief condition / angle-of-trim].
[0021] Invention of claim 9 is claim 1, claim 2, claim 3, claim 4, claim 5, claim 6, claim 7, and automatic attitude control equipment of a vessel according to claim 8, and said roll include angle detects the angular velocity of the roll direction of a hull with an oscillating gyroscope, and is characterized by integrating with and computing said angular velocity.
[0022] Invention of claim 10 is claim 1, claim 2, claim 3, claim 4, claim 5, claim 6, claim 7, and automatic attitude control equipment of a vessel according to claim 8, and said roll include angle detects the acceleration of the roll direction of a hull with an accelerometer, and is characterized by computing the tilt angle of said hull based on said acceleration.
[0023] Invention of claim 11 is claim 1, claim 2, claim 3, claim 4, claim 5, claim 6, claim 7, and automatic attitude control equipment of a vessel according to claim 8, and said roll include angle is characterized by detecting the tilt angle of the roll direction of a hull with an inclinometer.
[0024] Invention of claim 12 is claim 1, claim 2, claim 3, claim 4, claim 5, claim 6, claim 7, and automatic attitude control equipment of a vessel according to claim 8, and said yaw include angle detects the relative bearing of a hull with a magnetometric sensor, and is characterized by outputting this as a yaw include angle.
[0025] Invention of claim 13 is automatic attitude control equipment of a vessel according to claim 5, has the device which controls said trim tab automatically, and the device driven with hand control, and is characterized by being switchable to arbitration in this automatic and hand control.

[Translation done.]

OPERATION

[Function] According to invention of claim 1 of the above-mentioned means, based on the roll include angle of a hull, a yaw include angle, and vessel speed, a driving means can be controlled by the controller and the include angle of a trim tab can be changed.
[0027] According to invention of claim 2, based on the roll include angle of a hull, a yaw include angle, and the include angle of vessel speed and a trim tab, a controller can control a driving means, and the include angle of a trim tab can be changed.
[0028] According to invention of claim 3, from a yaw include-angle signal and a speed signal, the NAV condition of a ship can be judged and the include angle of a trim tab can be controlled by the roll include-angle signal and the trim-tab include-angle signal according to a NAV condition.
[0029] The heel include-angle signal and heel include-angle desired value signal which according to invention of claim 4 inputted the yaw angular rate and the velocity level, judged the NAV condition, and enabled the change of the control approach based on the judgment of this NAV condition, and equalized the roll include-angle signal A target trim-tab include angle is set up beforehand, tab include-angle desired value is further chosen with the control approach change signal, tab angle desired value is outputted, heel include-angle deflection can be calculated, and the desired value of a trim-tab include angle can be calculated by the ability considering this heel include-angle deflection signal as an input, and tab include-angle deflection can be calculated by the ability to input tab include-angle desired value and a trim-tab include-angle signal, and a driving signal can be outputted.
[0030] according to invention of claim 5 -- a NAV condition -- responding -- heel include-angle control and revolution tense -- a bow -- the trim-tab include-angle control in a relief condition can be chosen, and the desired value determined in each control approach can be outputted.
[0031] According to invention of claim 6, from a yaw include-angle signal and a speed signal, a NAV condition can be judged, the include angle of a trim tab can be controlled by the heel include-angle signal and the trim-tab include-angle signal, and heel include-angle control can be performed.
[0032] According to invention of claim 7, when a NAV condition is judged and it is judged as the time of revolution from a yaw include-angle signal and a speed signal, a trim tab can be set as the desired value set up beforehand.
[0033] According to invention of claim 8, a NAV condition can be judged with a speed signal and a trim tab can be controlled to the desired value set up beforehand.
[0034] According to invention of claim 9, a roll include angle can be computed by the ability for an oscillating gyroscope to detect the angular velocity of the roll direction of a hull, and integrate with angular velocity.
[0035] According to invention of claim 10, an accelerometer can detect the acceleration of the roll direction of a hull, the tilt angle of a hull can be computed based on this acceleration, and it can ask for a roll include angle.
[0036] According to invention of claim 11, an inclinometer can detect the tilt angle of the roll direction of a hull, and it can ask for a roll include angle.
[0037] According to invention of claim 12, a magnetometric sensor can detect the relative bearing of a hull and this can be outputted as a yaw include angle.
[0038] According to invention of claim 13, automatic and hand control can be changed to arbitration and a trim tab can be controlled.

[Translation done.]

* NOTICES *

EXAMPLE

[Example] Hereafter, the example of this invention is explained.
[0040] Drawing 1 is the general drawing of a system configuration seen from the hull upper part.
[0041] 1 is a hull, 2 is a handle and he is trying for the turning effort of a handle 2 to rock a screw 5 right and left through a wire 3. Said screw 5 which can give turning effort with an engine 4 is connected to an engine 4. He changes the direction of a thrust and is trying to make it circle in a hull by rocking a screw 5 right and left by rotation of a handle 2.
[0042] The yaw angle sensor 11 which detects the deflection include angle to the longitudinal direction of a bow, the roll angle sensor 12 which detects the agitation angle of the longitudinal direction of a hull, and the rate sensor 15 which detects the rate of a hull are connected to a controller 10. In addition, a roll include angle can detect the angular velocity of the roll direction to a hull with an oscillating gyroscope, and can integrate with and compute said angular velocity. Moreover, it can ask by an accelerometer's detecting the acceleration of the roll direction of a hull and computing the tilt angle of a hull based on this acceleration. Furthermore, it can ask for a roll include angle by detecting the tilt angle of the roll direction of a hull with an inclinometer. A yaw include angle can detect the relative bearing of a hull with a magnetometric sensor, and can output this as a yaw include angle.
[0043] He is trying to input into a controller 10 the yaw include-angle signal omega detected by said yaw angle sensor 11, the roll include-angle signal phi detected by the roll angle sensor 12, and the speed signal upsilon detected by the rate sensor 15, respectively.
[0044] Moreover, the manually-operated switch (14R for right trim tabs, 14L for left trim tabs) for operating manually the transfer switch 13 and trim tabs 6R and 6L which switch whether the angle sensor (16R for right trim tabs, 16L for left trim tabs) which detects the include angle of trim tabs 6R and 6L, and trim tabs 6R and 6L are controlled automatically, or it operates manually is connected to a controller 10.
[0045] Furthermore, the controller 10 is connected with the dc-battery 9 through an electric power switch 17. When an electric power switch 17 is OFF, it has composition which actuation of a controller 10 suspends.
[0046] The controller 10 has connected the output to the driving means which changes the include angle of trim tabs 6R and 6L according to the signal outputted from a controller 10.
[0047] The driving means of the trim tabs 6R and 6L of this example is constituted as follows. An output signal is embraced from a controller 10, and hydraulic motors 8R and 8L are rotated normally and reversed. According to normal rotation of hydraulic motors 8R and 8L and reversal, Cylinders 7R and 7L perform flexible movement. Trim tabs 6R and 6L are made to move up and down by flexible movement of these cylinders 7R and 7L.
[0048] Next, drawing 2 explains the internal configuration of a controller 10.
[0049] A speed signal upsilon is first inputted into a controller 10 from said rate sensor 15, and this speed signal v is sent to the velocity level judging section 20.
[0050] The constant value v1 for judging a NAV condition and v2 (v1 and <v2) are beforehand set as the interior by this velocity level judging section 20. v1 the bow of a ** idling condition and a ship -- it is boundary value with a relief condition. v2 It is the boundary value of a ****** relief condition and a plane condition. This v1 and v2 A value can be set as any value according to the NAV conditions of a ship, or the property of a hull.
[0051] In addition, a property as generally shown in drawing 3 has the relation between vessel speed and an angle of trim.
[0052] In said velocity level judging section 20, the velocity level of a ship is classified into the following three kinds

by the following judgment type.
[0053]
(1) v<v1 (idling condition)
(2) v1 <=v<=v2 (bow relief condition)
(3) v2 <v1 (plane condition) -- At the time of the conditions of the 1st formula (1) (1) signal is outputted to the control approach change section 22.
[0054] At the time of the conditions of (2) (2) signals are outputted to the control approach change section 22.
[0055] At the time of the conditions of (3) (3) signals are outputted to the control approach change section 22.
[0056] Moreover, if the yaw include-angle signal upsilon is inputted into a controller 10 from said yaw angle sensor 11, this yaw include-angle signal omega will be sent to the rate-of-change count section 21.
[0057] Yaw angular rate which is yaw include-angle change for every unit time amount according to the yaw include-angle signal omega inputted in this rate-of-change count section 21 d omega/dt It calculates. And calculated yaw angular rate d omega/dt The rate-of-change count section 21 carries out a comparison operation to constant value domegao/dt set up beforehand, and chooses an output signal. Domegao/dt is boundary value the NAV condition of a ship judges the time of current, rectilinear propagation, and revolution to be. this -- The value of domegao/dt can be set as any value according to the NAV conditions of a ship, or the property of a hull. (**) d omega/dt < Domegao/dt (at the time of rectilinear propagation)
(**) d omega/dt >= Domegao/dt (at the time of revolution) -- 2nd formula (b) At the time of conditions (b) A signal is outputted to the control approach change section 22.
[0058] (b) At the time of ****** (b) A signal is outputted to the control approach change section 22.
[0059] Instruction signal when the velocity level signal from the aforementioned velocity level judging section 20 and the rate-of-change signal from the aforementioned rate-of-change count section 21 are inputted into the control approach change section 22, as shown in drawing 4 in the control approach change section 22 with the combination of the velocity level signal and rate-of-change signal which were inputted (i) - (iii) It determines and outputs to the desired value selection sections 30 and 31.
[0060] Change instruction signal (i) - (iii) (i) Instruction signal changed into the condition of having raised the trim tab to the top
(ii) Instruction signal which changes a trim tab into the condition of having lowered to the bottom
(iii) Instruction signal which performs heel include-angle control
It means.
[0061] Namely, it is a change instruction signal (i) regardless of a judgment at the time of rectilinear propagation [in / when the velocity level of the ship in the 1st formula is judged to be an idling condition / the 2nd formula], and revolution. That is, a trim tab is controlled in the condition of having raised to the top.
[0062] moreover, the velocity level in the 1st formula -- a bow -- when it judges with a relief condition (run state before plane shift), the change instruction signal (ii) 6R and 6L, i.e., trim tabs, is controlled in the condition of having lowered most, regardless of a judgment at the time of the rectilinear propagation in the 2nd formula, and revolution.
[0063] This has the effective control which was mentioned above and which lowers a bow until it shifts to a plane condition like, and rolling control in this condition and heel include-angle control are because there is little effectiveness.
[0064] furthermore, the case where it is judged with the time of rectilinear propagation by the 2nd formula when the velocity level in the 1st formula is judged to be a plane condition -- change instruction signal (iii) namely, the case where heel include-angle control is judged to be the time of operation and revolution -- change instruction signal (i) That is, it controls in the condition of having raised trim tabs 6R and 6L most.
[0065] Thereby, at the time of rectilinear propagation, only a plane condition carries out heel include-angle control, and it controls not to check the heel which is the property which a ship originally has at the time of revolution.
[0066] On the other hand, the roll include-angle signal phi is inputted into a controller 10 from the roll angle sensor 12, and this roll include-angle signal phi is sent to the average processing section 23.
[0067] In this average processing section 23, from the inputted roll include-angle signal phi, the 3rd following formula is calculated and a moving average deviation is calculated. This moving average deviation is set to heel include-angle phia.
[0068]

[Equation 1]

$$\phi a k = \frac{1}{n'} \sum_{i=k-n'}^{k} \phi i \quad \cdots第3式$$

ここでiは $(k-n')$, $(k-n'+1)$, $(k-n'+2)$, ……, k

$(K-(k-n'+n'))$

As for roll include-angle phiak in i time, phii shows the heel include angle in k time.
[0069] phiak, i.e., phii, is n'. It is the average of the value which ****(ed).
[0070] phi makes a dextroversion oblique position forward to a travelling direction.
[0071] Heel include-angle phia calculated by the 3rd formula is made into an output signal, and it outputs to the heel-angle deflection count section 25.
[0072] Target heel include-angle signal phio which shows the target heel include angle beforehand set to this heel-angle deflection count section 25 in the desired value decision section 24 in addition to this It has inputted.
[0073] In this heel-angle deflection count section 25, the 4th following formula is calculated and it asks for heel include-angle deflection signal phie.
[0074]
phie=phia-phio -- A hull makes the clockwise direction forward to a travelling direction here the 4th formula.
[0075] This heel include-angle deflection signal phie is outputted to the tab include-angle desired value count sections 26 and 27.
[0076] In the tab include-angle desired value count section 26, after judging the positive/negative of phie based on inputted heel include-angle deflection signal phie, the PID operation of the 5th formula is performed and it asks for tab include-angle desired value thetar of a right trim tab.
[0077]
[Equation 2]
$\phi e \geqq 0$なら

$$\theta r = K_p \phi_e + T_D \frac{d}{dt} \phi_e + \frac{1}{T_I} \int \phi_e \, dt \quad \cdots第5式$$

$\phi e < 0$なら

$\theta r = 0$

ここで、K_p, T_D, T_I は定数である。

After judging the positive/negative of phie based on inputted heel include-angle deflection signal phie in the tab angle desired value count section 27, the following PID operation of the 6th formula is performed and it is tab angle desired value thetal of left trim-tab 6L. It asks.
[0078]
[Equation 3]

$\phi e \geqq 0$なら

$\theta \ell = 0$

$\phi e < 0$なら

$$\theta \ell = -\left(K_p \phi_e + T_D \frac{d}{dt} \phi_e + \frac{1}{T_I} \int \phi_e \, dt\right) \quad \cdots第6式$$

ここで、K_p, T_D, T_I は定数である。

In addition, the 1st term Kpphie of the 6th formula gives the tab include angle proportional to heel include-angle deflection signal phie to the 5th formula list. That is, the tab include angle of the right or the left is enlarged, so that the absolute value of heel include-angle deflection signal phie is large.
[0079] This 2nd term does not give the tab include angle proportional to the differential value of heel include-angle deflection signal phie, if this differential value is not large, it gives that much big tab include angle, and it is raising the responsibility which decreases the heel include angle of a hull.
[0080] This 3rd term gives the tab include angle proportional to the integral value of heel include-angle deflection signal phie, and this has given the tab include angle which negates the heel (heel include angle) of the steady hull produced according to the property and external force of a hull.
[0081] Right tab angle desired value thetar called for here is outputted to the desired value selection section 30. Moreover, left tab desired value thetal It is outputted to the desired value selection section 31.
[0082] Explanation to the output signal decision of a right trim tab is given to below. The flow to the output-signal decision of a left trim tab is completely the same as a right trim tab, and explanation is omitted.
[0083] Change instruction signal outputted to the target selection section 30 from the above mentioned control approach change section 22 (i) - (iii) The right tab angle desired value setting section 28 which set up the target tab angle beforehand although tab include-angle desired value thetar outputted from the right tab include-angle desired value count section 26 was inputted to the target set point theta 1, and theta 2 It has inputted. Target set point theta 1 It is the set point in the condition of having raised trim-tab 6R most. Target set point theta 2 It is the set point in the condition of having lowered trim-tab 6R most.
[0084] At the desired value selection section 30, it is a change instruction signal (i). - (iii) It corresponds and is desired value thetar of a right tab include angle, theta 1, and theta 2. It chooses. The selection correspondence is as follows.
[0085]
change instruction signal Tab angle desired value (i) The time theta 1 Selection (ii) The time theta 2 Selection (iii) The time thetar selection -- the right tab include-angle desired value chosen by this -- thetaR =theta1 -, theta 2, or thetar ** -- it carries out.
[0086] Right tab include-angle desired value thetaR chosen in the desired value selection section 30 It is outputted to the right tab angle deflection count section 32.
[0087] Tab angle desired value thetaR inputted into the right tab angle deflection count section 32 Include-angle signal thetaRo detected by trim-tab angle sensor 16R is also inputted into others.
[0088] The 7th following formula is calculated in the right tab angle deflection count section 32, and it is deflection include-angle thetae. It asks. thetae =thetaR-thetaRo -- It is thetae to the 7th formula pan. Positive/negative distinction is performed and it is deviation-angle thetae. The signal which rises and brings down trim-tab 6R so that it may become zero is determined as follows.
[0089]

thetae When it is forward Down signal (0RD)
thetae When it is negative Rise signal (0RU)
This rise down signal is outputted to the right output section 34.
[0090] In the right output section 34, the change signal and the manual ringing from right manual switch 14R which rise down signal 0RU or 0RD determined in the right tab angle deflection count section 32 is considered as an input, and also consider an on-off signal as an output from a changeover switch 13 are inputted.
[0091] That is, he is trying to change automatic and manual trim-tab control in the right output section 34 with the change signal inputted from a changeover switch 13.
[0092] When a changeover switch 13 is ON, it considers as automatic, and it outputs to hydraulic-motor 8R by making into an output signal rise down signal 0RD or 0RU determined above.
[0093] When a changeover switch 13 is OFF, it considers as hand control, and the rise down signal determined by actuation of right manual switch 14R is outputted to hydraulic-motor 8R as an output of the right output section 34.
[0094] Although control of right trim-tab 6R was explained above, the same is said of the left trim-tab 6L.
[0095] Here, there are little increase of water pressure which starts a ship's bottom since the draft of the stern is deep until it goes into a plane condition in a planing boat, and rolling. Actuation which lowers a bow when right and left take down a trim tab conventionally, since the shift to a plane becomes slow while a bow goes up by subduction of the stern on the other hand in the meantime and a front field of view gets worse is performed, and control of the example of this invention also applies to this.
[0096] On the other hand, in a plane condition, a draft becomes shallow and agitation of a ship becomes active. When rolling is compared with pitching in this condition, the pitching period is usually longer and the direction of rolling is felt sensitively. Moreover, although the effectiveness of lowering the bow which went up too much on the structure, as for the attitude control using a trim tab is expectable, there is no effectiveness of raising the bow which fell too much. Therefore, the attitude control in a plane condition has more effective control of rolling.
[0097] However, since a great quantity of loads will be given to a control actuator, always controlling all rolling does not tend to press down the agitation angle (rolling) of a hull itself, and it controls the average attitude angle (this is called heel angle) by the example of this invention.
[0098] Moreover, about the invalid nature of the rolling control at the time of revolution, although it is as above-mentioned, it uses that the level of the yaw angular rate in each differs at the time of rectilinear propagation and revolution for detection of a revolution condition. That is, if level with a yaw angular rate is exceeded, it can be judged as revolution.
[0099] Next, the control action of the above-mentioned controller 10 is explained based on the flow chart of drawing 9 from drawing 5 . In addition, also in this explanation, it carries out about control of right trim-tab 6R, and control of left trim-tab 6L is omitted.
[0100] First, overall control is performed like drawing 5 . That is, the change of the control approach is performed in step S1. The change of this control approach is said instruction signal (i). An instruction signal (ii) and instruction signal (iii) It is a change.
[0101] Tab include-angle count is performed at step S2. Tab include-angle count is performed based on detection of said roll angle sensor 12 (drawing 1).
[0102] Desired value selection is performed at step S3. Desired value selection embraces a NAV condition and is tab include-angle thetar, theta 1, and theta 2. It chooses.
[0103] In step S4, tab include-angle deflection count and an output are performed. Tab include-angle deflection count is selected desired value thetaR. It is calculated based on the trim-tab include angle detected by trim-tab angle sensor 16R (drawing 1). An output outputs the signal of a rise or a down to hydraulic-motor 8R so that deflection may be set to 0.
[0104] Next, the detail of step S1 - S4 is explained.
[0105] The change of the control approach of said step S1 is performed by the routine of drawing 6 . At step S101, reading of the rate v detected by the rate sensor 15 (drawing 1) is performed first.
[0106] The judgment of a velocity level is performed at step S102. It is (1), as this judgment was performed in the velocity level judging section 20 (drawing 1) and being described above. v<v1 (2) v1 <=v<=v2 (3) It is carried out about v2 <v and is v<v1. A case is (1) at step S103. Selection of a signal is performed.
[0107] v1 <=v<=v2 A case is (2) at step S104. Selection of a signal is performed.

[0108] v2 In <v, set to step S105 and it is (3). Selection of a signal is performed.
[0109] Subsequently, reading of the yaw include angle omega detected by the yaw angle sensor 11 (drawing 1) in step S106 is performed.
[0110] A judgment of a NAV condition is made at step S107. This decision is performed in the rate-of-change count section 21 (drawing 1), and as described above, it carries out about (b) d omega/dt<d omega0 / dt (b) d omega/dt>=d omega 0 / dt.
[0111] In d omega/dt<d omega 0 / dt, selection of a (b) signal is performed in step S108.
[0112] In d omega/dt>=d omega 0 / dt, selection of a (b) signal is performed at step S109. If these signal selections are performed, based on these signals, a judgment of a rate and a NAV condition will be made in step S110. This judgment is made like said drawing 4 in the control approach change section 22.
[0113] Namely, (1) And (**) and (1) And (**) and (3) It reaches, in (**), it sets to step S111, and is (i). Selection of a signal is performed.
[0114] (2) And (**) and (2) And in (**), selection of the (ii) signal is performed in step S112.
[0115] (3) And when it is (**), set to step S113 (iii). Selection of a signal is performed.
[0116] These (i) A signal and (ii) signal (iii), The change of the control approach can be judged with a signal. therefore, the step S114 -- setting -- (i) or (ii) -- or (iii) it was chosen -- it changes and a signal is outputted.
[0117] Next, tab include-angle count of step S2 of said drawing 5 is performed by the routine of drawing 7 . In step S201, reading of detection roll angle phi is performed first. This reading is based on detection of said roll angle sensor 12 (drawing 1).
[0118] Subsequently, count of moving average deviation phia is performed in step S202. This average processing is performed in the average processing section 23 (drawing 1). Moving average deviation phia is outputted as a heel include angle, as described above.
[0119] It sets to step S203 and is decision target ground phio. Read in is performed. This decision target ground phio It is based on the value beforehand determined in said desired value decision section 24 (drawing 1).
[0120] Heel include-angle deflection count is performed at step S204. This heel include-angle deflection count is performed in the heel include-angle count section 25 (drawing 1), and phie =phia-phio is performed.
[0121] At step S205, it is tab include-angle desired value thetar. Count is performed. This count is performed in the right tab include-angle desired value count section 26 (drawing 1), as described above.
[0122] Next, it sets to step S206 and is tab include-angle thetar. An output is performed. This output is performed from the right tab include-angle desired value count section 26 to the desired value selection section 30.
[0123] Desired value selection of step S3 of said drawing 5 is performed based on the routine of drawing 8 . This routine is performed by the desired value selection section 30 (drawing 1).
[0124] It is tab include-angle count desired value thetar at step S301 first. Read in is performed. This desired value thetar It is based on the output from said desired value count section 26 (drawing 1).
[0125] At step S302, it is the tab include-angle setting desired value theta 1 and theta 2. Read in is performed. This desired value theta 1 and theta 2 It is based on the output from the right tab include-angle desired value setting section 28 (drawing 1).
[0126] It changes at step S303 and is a signal (i). (ii) (iii), Read in is performed. This read in is based on the output from said control approach change section 22.
[0127] At step S304, it changes and decision of a signal is performed. (i) It sets to step S305 and a case is desired value theta 1. Selection is performed. In (ii), it sets to step S306 and is desired value theta 2. Selection is performed. (iii) It sets to step S307 and a case is desired value thetar. Selection is performed. The these-chosen desired value theta 1, theta 2, and thetar Either is desired value thetaR. It carries out and is outputted in step S308. This output is performed from said desired value selection section 30 to the right tab include-angle deflection count section 32.
[0128] The tab include-angle deflection count output of step S4 of said drawing 5 is performed by the routine of drawing 9 . This routine is performed by said right tab include-angle deflection count section 32 and the right output section 34.
[0129] The desired value theta 1 first chosen in step S401, theta 2, and thetar Read in is performed. This read in is based on the output from the desired value selection section 30 (drawing 1).
[0130] At step S402, read in of detected trim-tab angle thetaRO is performed. This read in is based on the output from said trim-tab angle sensor 16R (drawing 1).

[0131] Tab angle deflection count is performed at step S403. This count performs thetae =thetaR-thetaRO.
[0132] Subsequently, it sets to step 404 and is thetae. A positive/negative judging is performed. thetae When it is forward, the output of the down signal ORD is performed in step S405. thetae When it is negative, the rise signal ORU is outputted in step S406. Said hydraulic-motor 8R drives and a trim-tab angle is controlled by this output at a down or rise side.
[0133] And decision of being thetae =0 is performed in step S407, and control will be ended if set to 0.
[0134] Thus, according to the NAV condition of a ship, trim tabs 6R and 6L can be controlled, and an efficient and highly precise posture system can be performed automatically. Moreover, the load of hydraulic motors 8L and 8R can be made into min, and endurance and dependability can be improved.
[0135] An example of the effectiveness by the above-mentioned example of this invention is shown in drawing 10 .
[0136] Drawing 10 (a) The heel include-angle depressor effect in every rate of a ship in the condition of having received the flank wind at the time of rectilinear propagation is shown.
[0137] In control according [the continuous line in drawing] to this invention example, in not controlling, a broken line shows the case where a two-dot chain line performs rolling control over the whole region, respectively.
[0138] It turns out to disturbance, such as a flank wind, that this invention example has very effective heel include-angle depressor effect so that clearly from these.
[0139] Moreover, since it is small, not in extent as which human being senses displeasure but in this field, the control effectiveness is known by that it is few, as the inclination in the field in front of non-controlled heel include-angle play NINGU was described above.
[0140] Drawing 10 (b) The trim depressor effect by this invention is shown similarly. In control according [the continuous line in drawing] to this invention, in not controlling, a broken line shows the case where a two-dot chain line performs pitching control over the whole region, respectively.
[0141] the bow according to the trim inhibitory control before play NINGU by this invention example so that clearly from these -- it turns out well the relief prevention effectiveness is not only acquired, but that trim depressor effect continues after play NINGU which is trim control sheep regulatory region.
[0142] Moreover, even if it performs trim inhibitory control in a low-speed area and the maximum high-speed region, effectiveness is well known by that it is small.
[0143] As mentioned above, although the configuration of the above-mentioned example, control logic, an operation, and effectiveness were explained, this invention is not limited to the configuration and control logic of the above-mentioned example.
[0144] For example, it is a correction term for raising control precision about each 2nd term and each 3rd term in the 5th formula and the 6th formula, and it is also possible to omit one of these or both sides.
[0145] Moreover, it sets in the tab angle deflection count sections 32 and 33, and is deflection include-angle thetae by the 7th formula. Although the rise down signal of a trim tab is outputted and driven in the output sections 34 and 35 after asking, it is also possible to drive a trim tab with the tab angle desired value itself chosen in the desired value selection sections 30 and 31.
[0146] In this case, the tab angle deflection count sections 32 and 33 and the trim-tab angle sensors 16R and 16L become omissible.
[0147] Moreover, in this configuration, a comparison operation with the roll angle after control is performed, and it cannot be overemphasized that feedback of the deflection by study etc. is possible.
[0148] It cannot be overemphasized that you may be the object which will not be limited to the object of a proper if said control is possible, and has two or more functions by one also about each sensor in an example.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the structure-of-a-system Fig. which looked at the hull which applied the example of this invention from the upper part.
[Drawing 2] It is the block diagram of the controller concerning one example of this invention.
[Drawing 3] It is the graph which shows the general relation between the vessel speed of a ship, and whenever [angle-of-trim].
[Drawing 4] It is the graph showing the control pattern concerning one example of this invention.
[Drawing 5] It is an overall flow chart concerning one example of this invention.
[Drawing 6] It is a flow chart concerning the change of the control approach.
[Drawing 7] It is a flow chart concerning tab include-angle count.
[Drawing 8] It is a flow chart concerning desired value selection.
[Drawing 9] It is a flow chart concerning a tab include-angle deflection count output.
[Drawing 10] It is the graph which takes effect.
[Description of Notations]
1 Hull
2 Handle
3 Wire
4 Engine
5 Screw
6R, 6L Trim tab
7R, 7L Cylinder (driving means)
8R, 8L Hydraulic motor (driving means)
10 Controller
11 Yaw Angle Sensor
12 Roll Angle Sensor
13 Transfer Switch
14R, 14L Trim-tab manually-operated switch
15 Rate Sensor
16R, 16L Trim-tab angle sensor

[Translation done.]

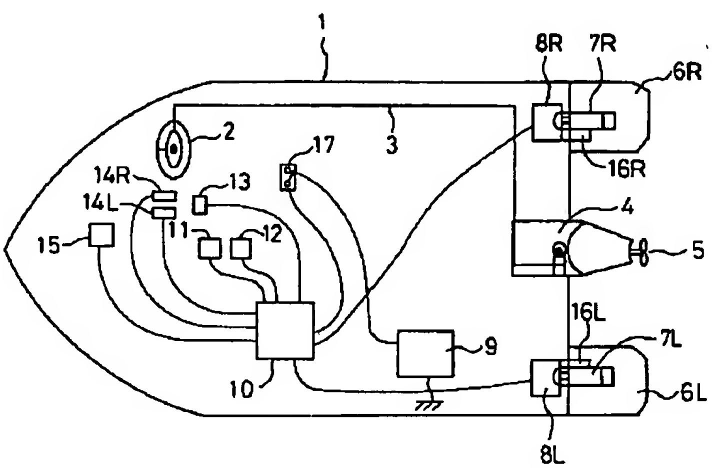
* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

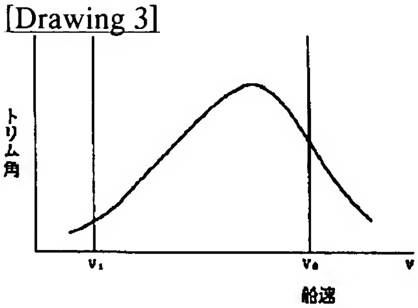
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

[Drawing 1]



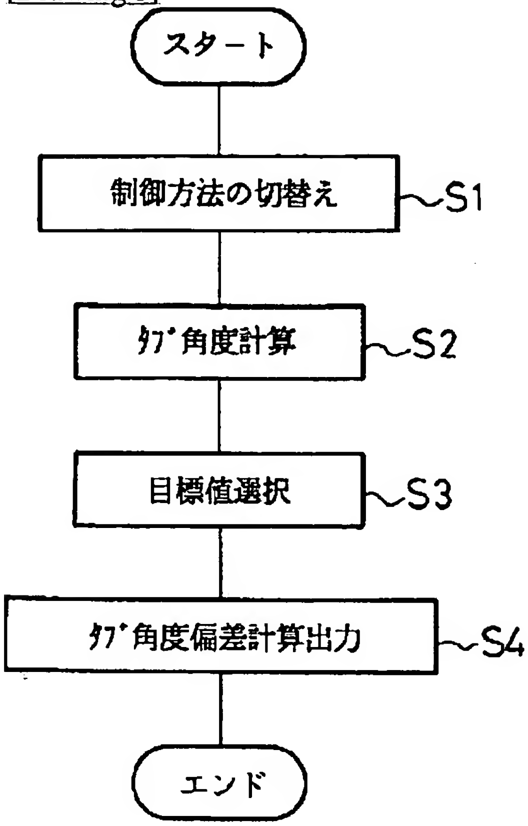
[Drawing 3]



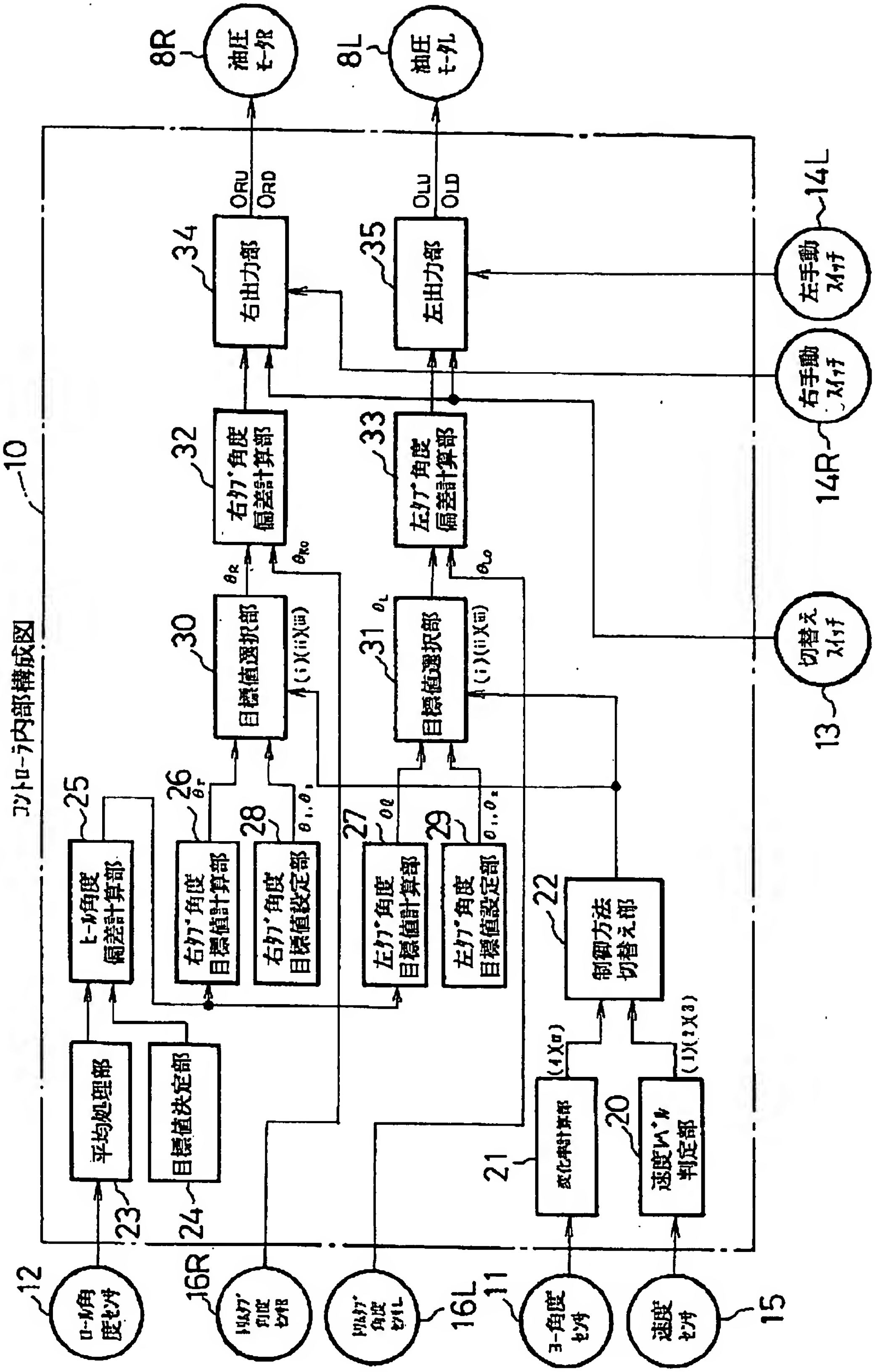
[Drawing 4]

プレーン状態判定部出力信号	変化率計算部出力信号	制御方法切替え部出力信号
(1)	(イ)	(i)
	(ロ)	(i)
(2)	(イ)	(ii)
	(ロ)	(ii)
(3)	(イ)	(iii)
	(ロ)	(i)

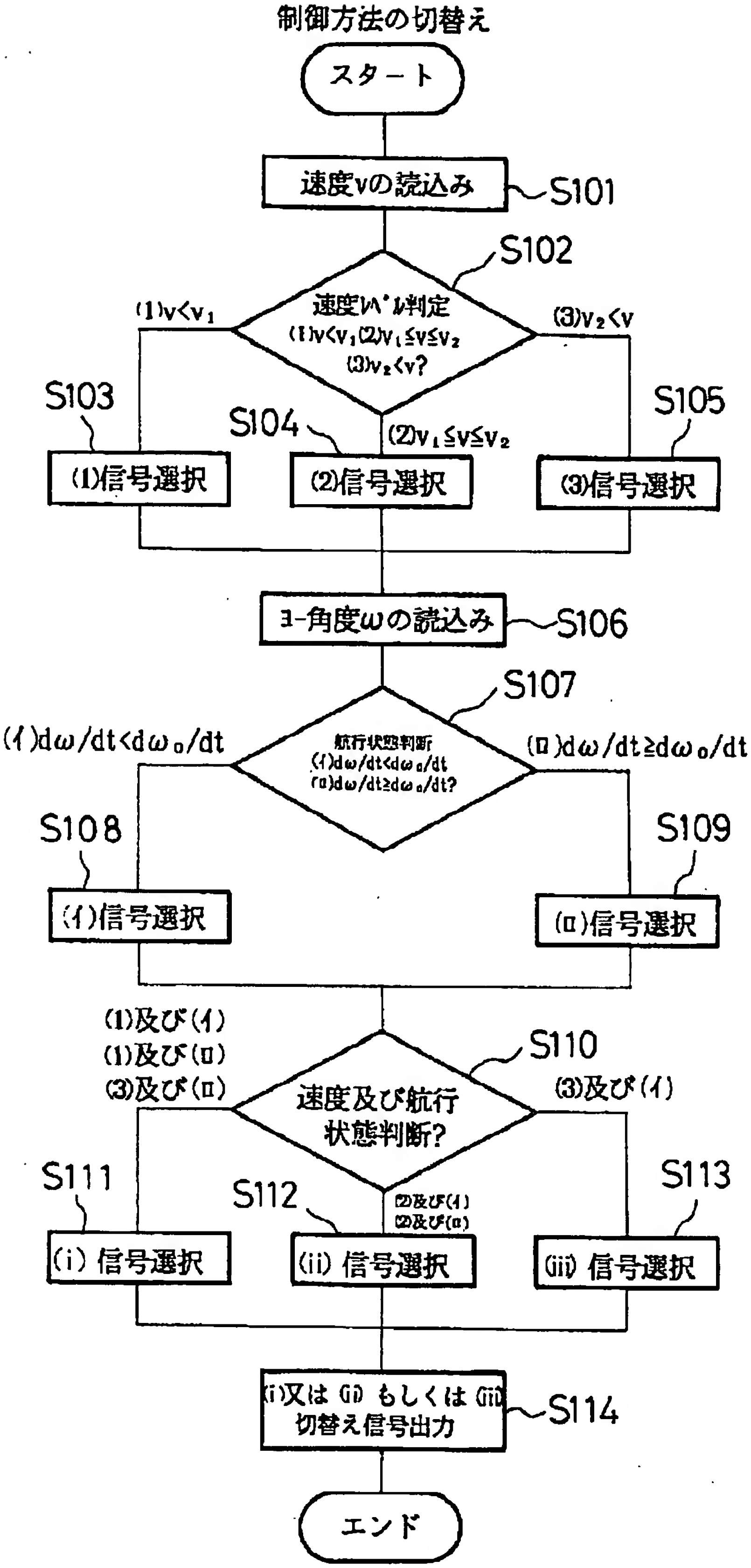
[Drawing 5]



[Drawing 2]

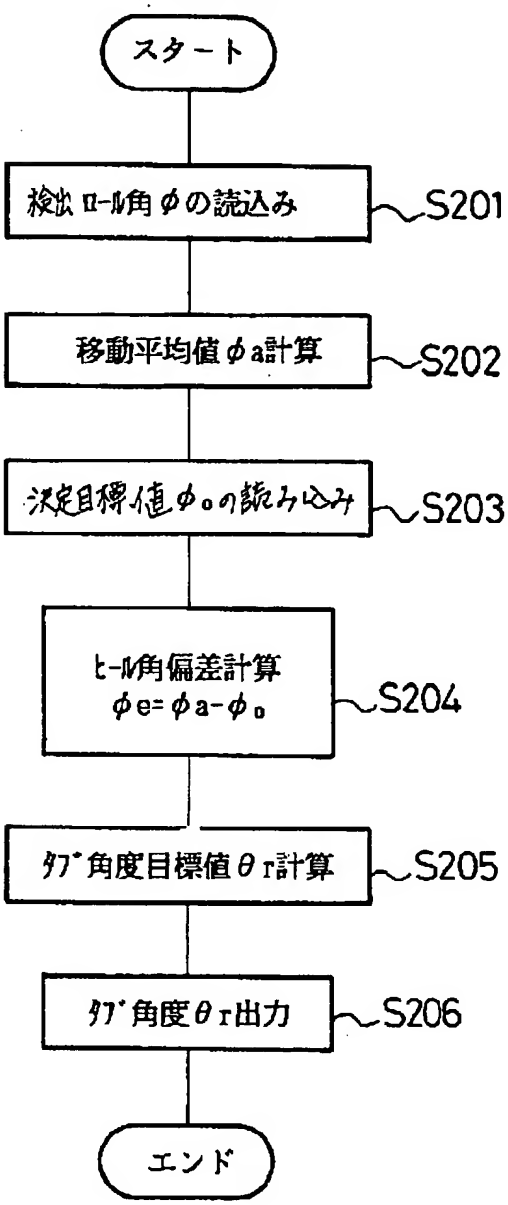

コントローラ内部構成図
平均処理部
目標値決定部
目標値選択部
右出力部
左出力部
制御方法切替え部
速度レベル判定部
速度センサ
切替えスイッチ
右手動スイッチ
左手動スイッチ
8R
8L
10
11
12
13
14R
14L
15
16R
16L
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35

[Drawing 6]

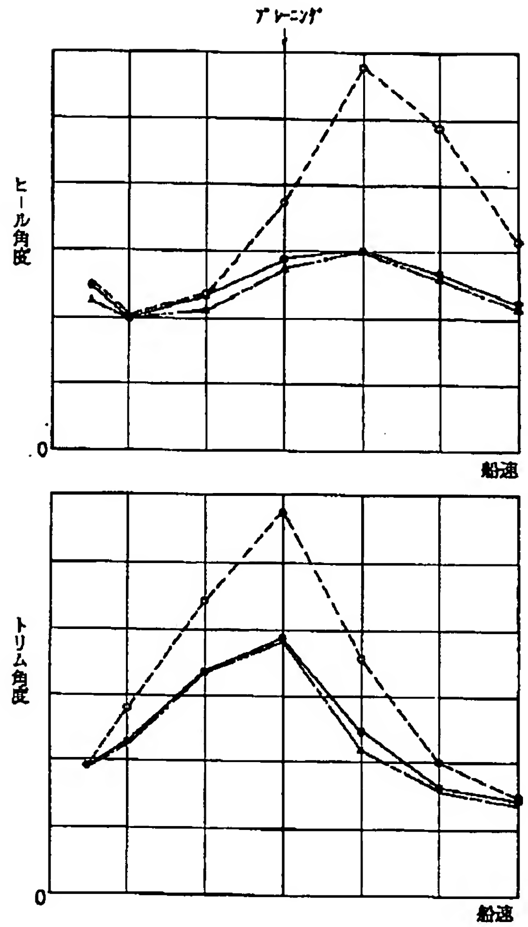

制御方法の切替え
スタート
速度vの読込み
S101
S102
速度レベル判定
(1)v<v1
(3)v2<v
S103
S104
(2)v1≦v≦v2
S105
(1)信号選択
(2)信号選択
(3)信号選択
ヨー角度ωの読込み
S106
S107
(イ)dω/dt<dω0/dt
航行状態判断
(ロ)dω/dt≧dω0/dt
S108
S109
(イ)信号選択
(ロ)信号選択
(1)及び(イ)
(1)及び(ロ)
(3)及び(ロ)
S110
速度及び航行状態判断?
(3)及び(イ)
S111
S112
(2)及び(イ)
(2)及び(ロ)
S113
(i) 信号選択
(ii) 信号選択
(iii) 信号選択
(i)又は(ii)もしくは(iii)
切替え信号出力
S114
エンド

[Drawing 7]

ﾀﾌﾞ角度計算



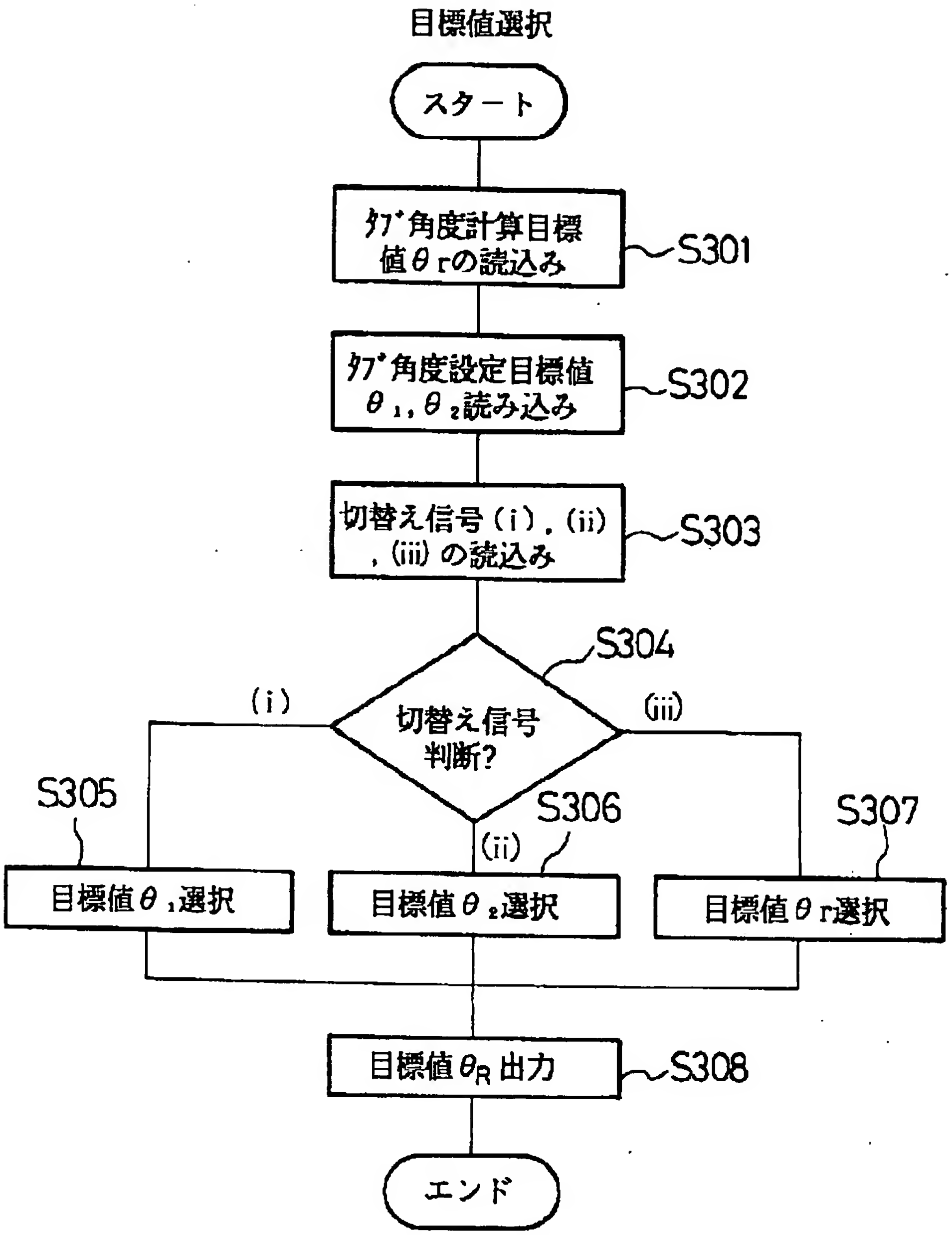
[Drawing 10]



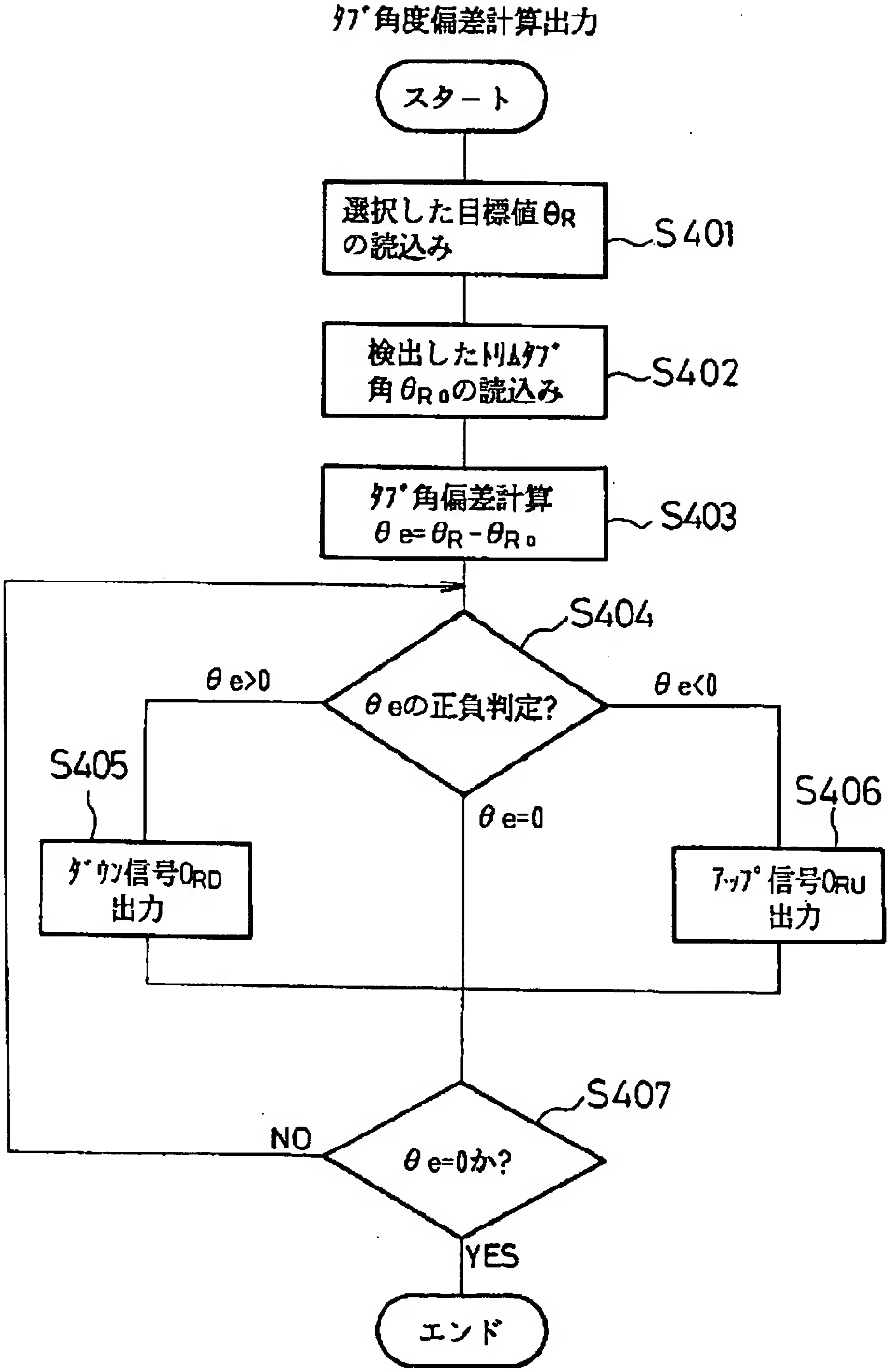
(a)

(b)

[Drawing 8]


目標値選択
スタート
ﾀﾌﾞ角度計算目標値θrの読込み
S301
ﾀﾌﾞ角度設定目標値θ1, θ2読み込み
S302
切替え信号（i），(ii)，(iii) の読込み
S303
S304
切替え信号判断?
(i)
(ii)
(iii)
S305
S306
S307
目標値θ1選択
目標値θ2選択
目標値θr選択
目標値θR出力
S308
エンド

[Drawing 9]



[Translation done.]